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REPORTS

OF THE

UNITED STATES COMMISSIONERS

TO THE

PARIS UNIVERSAL EXPOSITION, 1867.

PUBLISHED

UNDER DIRECTION OF THE SECRETARY OF STATE BY AUTHORITY
OF THE SENATE OF THE UNITED STATES.

EDITED BY
WILLIAM P. BLAKE,
COMMISSIONER OF THE STATE OF CALIFORNIA.

VOLUME V.

WASHINGTON:
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1870.

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BY

SAMUEL B. RUGGLES,

VICE-PRESIDENT OF THE UNITED STATES COMMISSION.

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BY

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PART I.

THE QUANTITIES OF CEREALS PRODUCED IN DIFFERENT COUNTRIES COMPARED.

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In the first arrangement by the Commissioners of the United States of the committees to examine and report upon the products exhibited, the duty in respect to "cereals" was allotted to a committee, of which the undersigned was a member; but on the addition of Mr. Hazard to the Commission, he was added to the committee; and the duty was thereupon divided by assigning to Mr. Hazard the special office of individually inspecting and of reporting upon the *qualities* and characteristics of the cereal specimens, and by committing to the undersigned the duty of collecting and reporting such information as might seem to be useful in respect to the comparative *quantities* produced by the different nations, and particularly in connection with the respective facilities of the countries for "ocean transportation." In the city of Buffalo, that important emporium of the commerce of our great inland lakes, Mr. Hazard had honorably filled the office of president of its Board of Trade. Not only in that capacity, but as a practical dealer in grain for many years, by hundreds of thousands of bushels, he had become peculiarly qualified to judge of the qualities of the cereals exhibited at Paris.

The thorough manner in which Commissioner Hazard has discharged the portion of duty committed to his care fully appears in his interesting report transmitted to the Department of State. It is only an act of justice to add that our country is also much indebted to him for the well-directed energy with which he personally and promptly aided, with the permission of the Commissioner General, in the work of arranging and bringing into proper order the cereal specimens sent from the United

States, so that they might exhibit in some degree the extent and variety of their culture.

In view of the possibility of future comparative exhibitions of the cereals of the United States and of Europe, the undersigned feels bound to report that the comparatively little time allowed by Congress for gathering in from ocean to ocean and methodically arranging here at home the numerous and varied specimens needed for the purpose, with the serious mistake of leaving wholly to individual citizens living widely apart, and without any common organization, the onerous duty of instituting all the necessary agencies and defraying all the expenses in the collection and preliminary arrangement of the specimens, placed the cereals of the United States exhibited at Paris at a great disadvantage when compared with the numerous and admirably classified specimens from the European nations, the governments of which had seasonably and adequately provided for their due preparation and exhibition. It is gratifying, however, to reflect that the experience gained in the late "Universal Exposition" can hardly fail to be useful in any future competition.

The area of the immense elliptical building erected at Paris for this great exhibition in the "*Champ de Mars*," (a locality happily chosen to show the superiority of civic over military displays,) was divided by concentric lines into seven elliptical rings or belts each nearly fifty feet wide. One of the outer belts in this series, more than two thousand feet in length, was occupied by the specimens of the "cereal products" of the whole family of civilized nations, placed in continuous line.

The moral and truly internationalizing influence of such an exhibition, grouping in harmonious concord the "corn" of the nations on both the continents, standing fraternally side by side, and typically encircling the world, will be readily comprehended.

The number of the visitors to the previous exhibition at Paris, in the year 1855, was 5,162,000; at the London exhibition of 1862, 6,211,000. The number at the Universal Exposition at Paris in 1867, as officially reported, by the "Imperial Commission," was 10,102,138. Day by day, for seven months, great multitudes thus passed in review this vast array of cereals, embracing every description of edible grains, from the antipodal plains of Australia, thirty degrees below the equator to the northernmost regions of Norway, within the polar circle, stretching off westward from the ancient food-bearing Euxine, across Europe and North America, to the Pacific coast of the American Union, now just opening its cereal treasures to the world.

It was indeed impossible to behold this impressive exhibition of the all-embracing bounty of Providence without a deep conviction, not only of the abundant ability of this "round world" to bring forth all the "corn" which it can need, but of the high moral truth that the nations of the earth, one and all, are bound by every consideration of duty to God and to man, to afford every facility in their power for the free

international transportation of cereals, unchecked by any impediment, either physical or legislative; that a large and enlightened Christian policy in removing needless obstacles can and will render any wide-spread famine on the globe hereafter impossible; and consequently, that "free trade in corn" is not only an axiom in political economy, but a sacred right of humanity, to be firmly interwoven into the common law of nations.

In undertaking the task of ascertaining the comparative cereal product of Europe and the United States, the undersigned was sufficiently aware of its difficulty not to attempt to complete the whole at once, in all its details. Most of the governments of Europe, and especially the "five great powers," annually collect statistics of their cereal product, more or less minute and accurate; but in some of the secondary nations on the Mediterranean and the Black Sea, the desired results could only be reached approximately from the estimates of their local statisticians, and in some instances only by comparison with the ascertained statistics of neighboring nations similar in soil and climate and the habits of their people.

The undersigned exerted his best efforts to collect at Paris all the attainable information bearing on this subject, and in this he was much aided by the kind co-operation and counsel of Monsieur Michel Chevalier, a distinguished senator of France, and a leading member of the Imperial Commission. His well-known statistical writings, at once so comprehensive and so accurate, have rendered him an authority on both sides of the Atlantic. The collection of the necessary materials from his copious and well-selected library was also facilitated by the valuable labors of Monsieur Ch. Vogel, an officer in the Department of Commerce of France, and specially recommended by M. Chevalier as being particularly conversant with the subject under inquiry. Through his intelligent co-operation it is believed that every statistical report or document then attainable at Paris, showing the cereal product of any considerable portion of Europe, or its export or import from nation to nation, was brought to light and carefully examined. His valuable notes, enriched with much interesting information in respect to the means of inland transportation of the cereals of Europe, are contained in a manuscript filling one hundred and twenty pages, but too voluminous to be embodied in the present report. A translation into English, carefully reducing to uniform measures of capacity and value the masses of figures used in stating the cereal products and the cereal commerce of the different nations in their varying measures, and deposited in the Department of State, might be useful in prosecuting any further inquiries on this subject.

Meanwhile, the undersigned, for the sake of greater convenience of examination and comparison, has sought to condense into one synoptical table the general results deduced from the particulars thus obtained at Paris, verified and enlarged to some extent by collateral and supple-

mental information. Without claiming or believing that the tabular statement now presented is entirely accurate in all its details, and especially in the classification in the "estimates" of the different species of cereals in two or three of the nations, or that it could not be rendered more precise by further and more thorough inquiry, he nevertheless is willing to claim that as a preliminary programme or outline it presents the leading features of the subject with sufficient accuracy for any practical purpose of general comparison, or of national or international action. If, in its present form, it should be found in any way useful to the government or to the people of the United States, in furnishing a guide for estimating the probable supply of cereals in the different nations, it may be readily corrected and modified from time to time hereafter, and so keep pace with any changes, if the Department of State should see fit to direct the yearly prosecution of the necessary systematic inquiries by the diplomatic and consular officers and agents of the United States in foreign countries. Any variation in the yearly product of any nation thus ascertained could be readily entered in the framework of the synoptical table, and thereby present to the country, in connection with our national decennial census and the intermediate census returns of the separate States, twice in each decade, the comparative progress of the United States and of Europe in supplying the cereal food of the civilized world.

It should be stated that in preparing the table now presented it was not found practicable to state all the results from all the nations from the crops of any single year. Nor would it have been altogether desirable; for the only reliable mode of ascertaining the relative cereal capacity of any country is to take the average of its crops for a series of years. In general, the most recent returns accessible were adopted, but in several important instances the average is stated of the crops for periods of five or seven years. The amount stated as the cereal product of Russia, the largest producer in Europe, is the average of seven years, from 1858 to 1864, embracing two large, two small, and three moderate harvests. The figures of the total product of forty-nine of its "governments" in Europe (1,358,437,500 bushels) are taken from the official report published at Paris in 1867, by M. de Buschen, member of the Central Statistical Committee at St. Petersburg, and entitled "Aperçu Statistique des Forces Productives de la Russie." It fails, however, to specify the different kinds of cereals embraced in the total product. Repeated efforts have since been made to obtain from St. Petersburg an official classification, but as yet without success. The basis on which they have been classified by "estimate" in the table is hereinafter stated.

In respect to France the product, both total and classified, is taken from the average of the crops of five years, from 1862 to 1866, inclusive, and officially reported to the government. There need be no fear of any serious inaccuracy in the cereal tables of that carefully governed

country, where the due supply of food, especially in Paris, is deemed a matter of the greatest importance. The vigilant eye of the government is never shut. Not a blade of wheat can grow, nor can a hen lay an egg, in any part of the empire, without an official report of the fact to the minister of agriculture.

In the British Islands, where the privacy of the homestead and the barnyard is held in closer reserve, but where the great national question of the due supply of food has become quite as vital, the statistics of their cereal product are annually and carefully collected, not directly by government officials, but by numerous and well-organized associations, under the constant advisement, if not the direct control, of the Board of Trade. It is mainly from their published reports, carefully reduced to synoptical form, that the results stated in the present table, in respect to the crop of the United Kingdom of Great Britain and Ireland, are taken. It states the average of five yearly crops, from 1863 to 1867, inclusive; which average, in point of fact, does not exceed that of the crops of the five years next preceding.

In view of the magnitude and importance of the results which might be exhibited by the table, and of its more ready and convenient use when constructed, it was deemed essential to reduce all the varying measures in use by the different nations to one common measure. It is true that the metric system, with its well-known "hectolitre," is steadily making its way in various portions of the continent of Europe; it has even reached the fertile and rapidly improving principalities on the Danube and Black Sea, now practically independent of Turkish rule. Through the influence of the enlightened prince at the head of their government, they have recently adopted not only the metric system, but with it the kindred international coinage of gold proposed by the "International Monetary Conference" at Paris in July, 1867. The powerful kingdom of Prussia, so rapidly rising to empire, is also on the eve of adopting the metric system. But several of the continental nations yet remain with their ancient and varying measures; and what is more important, all of them, without exception, still commit the error of estimating their cereals, in their official tables, by measures of capacity and not by measures of weight. In Germany cereals are estimated in "scheffels," in which there are several denominations in the different states and cities, all differing in capacity. The "tonnes" of Denmark, Sweden, and Norway, differ from each other. The "tschetwert" measures the immense cereal crop of the Russian empire, but in many of their public papers its equivalent in "hectolitres" is placed by its side. The imperial "bushel" of the United Kingdom, containing 2,218.192 cubic inches, differs in capacity by very nearly one thirty-second the "Winchester bushel" of 2,150.42 cubic inches, in general use in the United States.

In reducing all these measures to one common standard, an attempt was made to adopt the "Winchester bushel" of the United States, but

it was found to involve a great amount of needless labor, which could be avoided by taking the imperial bushel, which had been used in large masses of figures necessary to be compared with others. A further reason was, that the "hectolitre," which was used or referred to in the greater portion of the official returns from the continental nations, is much nearer than the Winchester bushel the comparatively even quantity of two and three-quarter bushels. The "imperial bushel" of eight to the "quarter" was therefore adopted as the common measure. The "scheffel" found in use in the official tables of the German Zollverein, containing 54.96 "litres," thereby approaching very nearly to eleven-twentieths of the "hectolitre," is computed in the table at one and a half bushels. The "tschetwert" is the precise equivalent of 209.726 "litres," or very nearly two and one-tenth "hectolitres." It is therefore estimated in the table at five and three-quarter bushels. The British "hundred-weight" of one hundred and twelve pounds avoirdupois is computed at one and five-sixths bushels.

These proportions are all assumed, not only in the table, but in all the statements of the present report, which seeks rather to present reasonable approximations than absolutely precise results. The construction of the table has, however, revealed very plainly what, indeed, had been learned by experience in all the grain-dealing markets, both in Europe and the United States, that the existing mode of estimating cereals by measures of capacity is and must be radically imperfect and erroneous. Its inherent absurdity is demonstrated at once by the fact that the different species of cereals differ widely in weight, and by the still further fact that the weight of the different varieties of the same species varies materially, not only in different countries, but in the varying soils and modes of culture in the same country. No comparative table of cereals can have any practical value unless it classifies the different species under separate heads, so that each may be computed by its actual weight. In point of fact and actual practice, all sales of cereals in any considerable quantities, in any of the ports of the United Kingdom or of the United States, whether on the oceans or the inland lakes, are now made only by measures of weight.

For the purpose of establishing a measure better fitted for stating the actual values of cereals, the British government, in the year 1864, took an important step in the right direction, by directing that all the cereals of every description thereafter to be exported from or imported into the United Kingdom should be entered and computed in the custom-houses only by "hundred-weights" of one hundred and twelve pounds avoirdupois. They further directed that all the cereal quantities in the voluminous table of the sixteen years next preceding, reaching back as far as 1852, and annually printed by order of Parliament in the "Statistical Abstract for the United Kingdom," and in which they had been stated in "quarters," should be recomputed and stated in "hundred-weights," in which convenient form they are now presented.

The undersigned will venture to hope that he may not be considered as traveling beyond his proper line of duty, but only as embracing a matter plainly kindred to the subject under examination, in now respectfully suggesting that the government of the United States might follow with much advantage the example thus set by the United Kingdom. It certainly would insure great accuracy in a comparative estimate of our cereal commerce, if the official cereal tables in our Treasury Department, including the custom-houses, were kept only by weight. It is not impossible that individuals might occasionally be found among our agricultural classes, in localities remote from the great commercial centers, who would prefer to sell their grain only by the bushel, and they would be left perfectly free to do so; but for all governmental or public purposes or large commercial dealings, the "bushel" has now become an obsolete and useless term. It may be safely and wisely sent into oblivion, to follow its kindred "pounds, shillings, and pence," which we discarded from our monetary system before the adoption of the national Constitution.

We have no need, in making this reform, to adopt the British "hundredweight" as our cereal unit. On the contrary, the "cental," which has been urgently recommended for several years by nearly all of our large commercial cities and institutions, and is now in universal use in our own rapidly expanding cereal regions on the Pacific, would be more in harmony with the decimal character of our national coinage. Being readily convertible into the one hundred and twelve pounds of the "hundredweight," it could hardly fail to facilitate our large and growing commerce in cereals with the United Kingdom, which has now become, and very probably will remain for a long time to come, the largest foreign consumer of the wheat and the Indian corn of the United States.

Before proceeding to examine more at large the very interesting relations between the two great branches of the Anglo-Saxon race in the matter of cereal food, it is necessary to ascertain the total cereal product of Europe as a whole, and the relation which it bears to our continental republic as a whole, the two being nearly equal in territorial extent. The product of Europe will be found stated by nations, and also by groups of nations, in the following synoptical table, embracing in a single view not only the total cereal product, but that of the several species, in each of the nations:

SYNOPTICAL TABLE

Showing the comparative cereal product of Europe and of the United States.

	Population.	Total cereal product.	Ratio to population.	Wheat.	Ratio to population.	Barley.	Rye.	Oats.	Buckwheat and millet.	Maize, "Indian corn."	Rice.
		Bushels.									60 pounds to bushel.
PRIMARY.											
1. European Russia, (reports from twenty-nine governments)	61, 325, 923	o 1, 358, 437, 500	22. 1	e 438, 437, 500	7. 1	e 230, 000, 000	e 260, 000, 000	e 360, 000, 000	e 40, 000, 000	e 29, 000, 000	e 1, 000, 000
Finland and Poland	6, 771, 102	e 125, 000, 000	18. 5	e 20, 000, 000	2. 9	e 15, 000, 000	e 45, 000, 000	e 40, 000, 000	e 5, 000, 000	....	....
	68, 097, 025	1, 483, 437, 500	20. 5	458, 437, 500	6. 7	245, 000, 000	305, 000, 000	400, 000, 000	45, 000, 000	29, 000, 000	1, 000, 000
2. Germany: Prussia	*38, 459, 646	o 737, 703, 774	19. 0	o 88, 679, 274	2. 4	o 53, 012, 500	o 320, 000, 000	o 250, 475, 000	o 25, 537, 000	....	....
3. France	37, 847, 478	o 710, 669, 279	18. 9	o 286, 928, 650	7. 6	o 57, 289, 611	o 108, 211, 464	o 206, 432, 302	o 30, 620, 904	o 21, 186, 348	....
4. Austria	32, 573, 002	o 486, 092, 000	15. 0	o 70, 200, 000	2. 1	o 74, 032, 000	o 119, 000, 000	o 149, 575, 000	o 13, 485, 000	o 58, 540, 000	o 1, 260, 000
5. Great Britain and Ireland	29, 866, 735	o 355, 053, 389	11. 9	o 110, 665, 217	3. 7	o 84, 074, 452	(†)	o 160, 313, 720	....	....	....
Total	206, 843, 886	3, 772, 955, 942	18. 2	1, 014, 910, 641	4. 9	513, 408, 563	‡852, 211, 464	1, 166, 796, 022	114, 642, 904	108, 726, 348	2, 260, 000
SECONDARY.											
6. Sweden and Norway	5, 815, 619	o 62, 000, 000	10. 6	o 2, 000, 000	0. 4	o 17, 000, 000	o 15, 000, 000	o 23, 000, 000	e 5, 000, 000	....	....
7. Denmark, (without the duchies)	1, 701, 200	o 23, 500, 000	13. 8	o 3, 000, 000	1. 8	o 15, 000, 000	o 1, 300, 000	o 3, 200, 000	o 1, 000, 000	....	....
8. Holland	3, 529, 108	o 36, 725, 900	10. 4	o 4, 801, 500	1. 3	o 4, 809, 000	o 11, 245, 700	o 12, 564, 700	o 3, 305, 000	....	....
9. Belgium	4, 940, 570	o 64, 297, 692	13. 0	o §16, 138, 936	3. 1	o 5, 513, 000	o ‖19, 794, 520	o 20, 389, 156	o 2, 462, 080	....	....
10. Switzerland	2, 510, 494	o 17, 200, 000	6. 8	o 2, 100, 000	0. 8	o 1, 400, 000	o 8, 500, 000	o 5, 200, 000	....	....	....
Total	18, 496, 991	203, 723, 592	12. 9	o 28, 040, 436	1. 5	43, 722, 000	55, 840, 220	64, 353, 856	11, 767, 080	....	....

SOUTHERN.											
11. Portugal, (continental)	3,987,861	*o* 29,503,367	7.4	*o* 5,944,825	1.5	*o* 1,886,747	*o* 4,482,664	*o* 517,467	....	*o* 16,201,664	*o* 470,000
12. Spain, (with Balearic Islands)	16,046,217	*e* 120,000,000	7.5	*e* 60,000,000	3.7	*e* 10,000,000	*e* 14,000,000	*e* 3,000,000	*e* 3,000,000	*e* 28,000,000	*e* 2,000,000
13. Italy	24,231,860	*o* 187,246,957	7.6	*o* 94,592,212	3.9	*o* 12,229,906	*o* 6,699,864	9,000,000	*o* 18,035,738	*e* 42,849,237	*o* 3,840,000
14. Greece, (with Ionian Islands)	1,325,340	*o* 9,300,000	7.0	*o* 3,200,000	2.4	*o* 1,800,000	*o* 1,300,000	*o* 200,000	....	*o* 2,800,000	....
15. Danubian Principalities:											
Roumania	3,864,848	*o* 136,439,963	25.0	*o* 42,620,330	11.0	*o* 21,851,100	*o* 6,723,602	*o* 4,039,840	*o* 6,000,000	*o* 55,205,091	....
Servia	1,078,281	*e* 14,000,000	13.0	*e* 4,000,000	3.7	*e* 3,000,000	*e* 500,000	*e* 500,000	*e* 1,000,000	*e* 5,000,000	....
16. European Turkey	10,500,000	*e* 110,000,000	8.8	*e* 40,000,000	3.2	*e* 25,000,000	*e* 10,000,000	*e* 3,000,000	....	*e* 30,000,000	*e* 2,000,000
Total	61,034,407	606,490,287	9.6	250,357,367	4.5	*e* 75,767,753	43,706,130	20,257,307	28,035,738	180,055,992	8,310,000
Totals of Europe	286,375,284	4,583,169,821	16.0	1,293,308,444	4.5	632,898,316	951,757,814	1,251,407,185	154,445,722	288,782,340	10,570,060
United States of America:											
By census of 1860**	31,145,186	*o* 1,221,428,452	38.2	*o* 165,834,491	5.3	*o* 15,146,209	*o* 20,320,780	*o* 172,006,004	*o* 17,112,584	*o* 827,886,425	*o* 3,121,959
By census of 1850	23,101,876	*o* 844,024,316	36.3	*o* 97,358,288	4.2	*o* 5,005,546	*o* 13,745,413	*o* 142,083,425	*o* 8,677,294	*o* 573,568,882	*o* 3,585,558
AFRICAN SIDE OF MEDITERRANEAN.											
Egypt	5,500,000	50,000,000	9.9	*e* 25,000,000	4.5	*e* 10,000,000	....	....	....	....	....
Algeria††	2,994,124	*o* 34,248,934	11.4	*o* 14,381,367	4.7	*o* 19,593,563	*o* 38,175	*o* 109,978	....	....	....

* Official for 23,565,836; same rates assumed for remaining 14,893,810. † Included with oats. ‡ Including "meslin," 47,746,617. § Including "spelt," 4,303,210.

‖ Including "meslin," 3,106,310.

** The increase in the population of the United States of America from 1850 to 1860 is 35 per cent. Increase of total cereal product in same period 41.5 per cent.; of wheat, 70.3 per cent.; of barley, 202 per cent.; of rye, 49 per cent.; of oats, 21 per cent.; of buckwheat and millet, 100 per cent.; of Indian corn, 44 per cent. Of rice there is a decrease of 15 per cent. In the quantities given a deduction of one thirty-second is made for difference between Winchester bushel and imperial bushel.

†† Tunis and Tripoli do not produce cereals enough for their own consumption, but import from Algeria and Malta. The exportation of cereals from Morocco is prohibited, and the product is not ascertainable. The cereal product of Anatolia, in Asiatic Turkey, is estimated at 25,000,000 bushels.

The quantities marked (*o*) are based on official returns; those marked (*e*) on statistical estimates. The "hectolitre" is computed at 2¾ imperial bushels of 2,218.192 cubic inches; the "scheffel" at 1½ bushel; the "tschetwert" at 5¾ bushels.

It will be seen at once that the cardinal fact presented by the preceding table is the present ratio of product to population in Europe and in the United States.

The product of Europe, with 286,375,284 inhabitants, is stated to be 4,583,169,821 bushels, being at the rate of sixteen bushels for each inhabitant.

The product of the United States, computed on the basis of the census of 1860, with 31,145,186 inhabitants, is 1,221,428,452 bushels, being at the rate of thirty-eight and one-tenth bushels for each inhabitant.

The question how far this ratio will probably be maintained, and how long, is one of sufficient gravity to merit careful inquiry. Among other important considerations it involves the question of the facilities for ocean transportation respectively enjoyed by Europe and the United States, and its comparative cost, with an examination to some extent of the present commercial distribution of the cereals of Europe and of the United States among the different nations.

This branch of inquiry involves so much of further research that the undersigned would ask leave to make it the subject of a subsequent communication to the Department of State.

Respectfully submitted.

SAMUEL B. RUGGLES,
United States Commissioner.

WASHINGTON, *March* 2, 1869.

PART II.

THE QUALITIES AND CHARACTERISTICS OF THE CEREAL PRODUCTS EXHIBITED.

NOTICES OF THE EXHIBITION OF CEREALS BY VARIOUS COUNTRIES—SUCCESSFUL CULTIVATION OF WHEAT AND CORN IN HIGH LATITUDES IN NORWAY AND SWEDEN—VALUABLE VARIETIES OF WHEAT EXHIBITED IN THE FRENCH SECTION—INADEQUATE CEREAL REPRESENTATION FROM THE UNITED STATES—EXHIBITION FROM CALIFORNIA, AND NOTE UPON THE PRODUCTION OF CEREALS IN THAT STATE—CORN FROM THE UNITED STATES—OBSERVATIONS IN CONCLUSION—UNEQUAL DISTRIBUTION OF THE CEREAL PRODUCT OF THE WORLD—INCREASING DEFICIENCY OF SUPPLY IN ENGLAND—RUSSIA THE MOST FORMIDABLE RIVAL OF THE UNITED STATES IN COMPETING FOR THE SUPPLY OF THE ENGLISH MARKET—NECESSITY FOR THE ADOPTION OF THE MOST PERFECT SYSTEM OF CULTIVATION, AND FOR CHEAPENING TRANSPORTATION.

The department of cereals, Group vii, Class 67, in the Universal Exposition at Paris, having been committed by the Commissioners of the United States to the undersigned for his personal examination, he now submits the following report:

Nearly all the countries, colonies, and islands of the civilized world were represented in the Exposition by specimens of the different varieties of edible grains that are cultivated between the degrees of 38° south and 70° north latitude.

RUSSIA.

Russia, through her minister of agriculture, contributed more than five hundred specimens of cereals from her extensive grain-producing districts, ranging from St. Petersburg to Siberia on the north, thence southward through the fertile valleys of the Don, the Dnieper, and the Dniester, to the Black Sea, and through the great valley of the Volga to the Caspian. Throughout this wide-spread region, possessing great diversity and adaptedness of soil and climate, wheat, corn, oats, rye, and barley are successfully cultivated, producing a large and annually increasing surplus for export, sufficient, in the opinion of some persons, were the means of transportation adequate, to supply the deficiencies of Europe. Excellent taste was manifested in the arrangement and display of the specimens, all being distinctly labeled with the name of the provinces or latitude of production; some of which were as follows, viz: "Saratoff, Samara, Orel, Toula, Vilna, Kharkoff, Erivan, St. Petersburg, Odessa, Don, Siberia, Bessarabia, Wibourg, Caucasia, Coula, Doghertan, &c. The collection embraced many excellent varieties of wheat. The white and red winter wheats from the valley of the Don and the provinces of Erivan, Kharkoff, and Vilna, were of good quality, and perhaps the best; but the specimens of winter wheats in this collec-

tion cannot be classed as of prime quality, being, with few exceptions, rough, long, and thick skinned. Spring wheat, being a more reliable crop, is cultivated to a much greater extent in Russia than the winter varieties; the specimens of spring wheat, consequently, were more numerous and liberal, representing the product of her vast wheat districts. Many of their samples, although sound in quality, would be considered in commerce of "low grade," the berry being small, rough, and dark colored. There were but few specimens which could be considered of prime quality, but a sufficient number were included in the collection to show that the finest varieties of this cereal can be produced in that country.

The specimens of rye were all of excellent quality—large, plump, and of good color.

There were several varieties of barley—huskless, black, &c.; the quality generally good.

There were but few specimens of corn, and those were of the small flint variety.

The samples of oats were numerous, and the quality very good.

EGYPT.

This country, the ancient granary and source of supply for the nations of Europe, contributed a well-arranged and interesting variety of specimens. The native varieties of wheat were of the type peculiar to that country—long, rough, and flinty, badly cleaned, and infested with weevil, evincing an imperfect husbandry. The best specimens in this collection were from Upper Egypt, labeled "acclimated," and grown from some of the best varieties which improved cultivation has produced in Italy, France, and England—countries which once obtained their supplies from the prolific delta of the Nile.

The specimens of corn were of the ordinary round flint variety.

The samples of barley, rye, and oats were of fair quality, but were badly cleaned.

AUSTRIA.

In every department the products of this country were displayed in magnificent profusion. The agricultural interests were carefully represented, and the specimens of cereals were numerous and arranged with good taste. The samples of wheat consisted of red and white winter, no specimens of spring being observed in the collection. All were of excellent quality, evincing a high state of cultivation; and some of these varieties, if introduced into the United States, would undoubtedly prove a valuable acquisition to its agricultural interests.

The specimens of corn, with one exception, which was "dent," and labeled "Florida," were all of the small, round, flint variety.

The specimens of barley, rye, and oats were of very superior quality.

TURKEY.

The Ottoman empire and its dependencies contributed a large number of specimens, but their crowded condition prevented a very thorough examination. The samples, so far as reached, were of the winter white, red, and amber varieties. These specimens partook strongly of the Egyptian type—long, rough, and thick skinned, badly cleaned, infected with weevil, and giving evidence of an inefficient system of agriculture.

Some very good specimens of round flint corn were noticed in this collection; also, a specimen of winter variety of oats, of fine quality. There was also one sample of rye of good quality. Some specimens of the black variety of barley, were large and plump, while the other varieties were ordinary.

GREECE.

The contributions of cereals from this country were quite numerous and well arranged. The specimens were of the red and white winter varieties only, of good quality and well cleaned, but generally rough and thick skinned.

The samples of corn were of the round flint variety, of good quality. Barley, oats, and rye were of ordinary quality.

ITALY.

This country was well represented in the department of cereals, and exhibited a large variety of excellent specimens of red and white winter wheat, some of which were of superior quality. A few specimens were noticed as the peculiar variety from which maccaroni is manufactured.

The specimens of corn were the ordinary round flint. The samples of barley, oats, and rye were of good quality.

PRUSSIA.

This country was unsurpassed in the neatness and finish of its agricultural department. The numerous and admirably arranged specimens of very superior qualities of grain gave evidence of the high state of cultivation which that country has obtained under the fostering care of its government, and the ability of soil and climate to produce the best varieties in great proportion. The specimens of winter wheat—white, red, and amber—were of excellent character, plump, thin skinned, and good color, possessing properties necessary to yield the largest quantity of superior flour. The specimens were labeled "Magdeburg," "Mecklenburg," "Brandenburg;" and some very superior samples were from private estates, and also from the government agricultural academies at Eldena, Pappelsdorf, and Waldau. A specimen labeled "Kalifornicher Weizen," (California wheat,) was nearly equal to the best California or Australian. A few good samples of spring varieties were noticed, but this kind of wheat is not cultivated to much extent in Germany. The

valleys of the Oder, the Vistula, and the Elbe yield some of the best winter wheats found in the English markets. The specimens of oats, barley, and rye were of excellent quality. The specimens of corn were inferior, small flint. This grain is not much cultivated in that country.

BAVARIA.

The specimens from this country, owing probably to the unfavorable condition of the weather during the harvest of 1866, were generally of ordinary character. There were some good varieties of winter wheat, but few of prime quality. One sample of spring wheat of excellent quality was noticed in this collection.

The samples of oats, barley, and rye were of ordinary quality.

HOLLAND.

This country made a moderate exhibition of white and red winter wheat, and a few specimens of spring wheat, all of good ordinary quality.

The specimens of oats, rye, and barley were all of good quality, and the collection was arranged in good taste.

NORWAY AND SWEDEN.

These countries excited some surprise by their well-arranged and excellent display of cereals grown between 58° and 70° north latitude. Even in these high latitudes the common cereals are cultivated to some extent, but the crops are unreliable, and the product supplies only a small proportion of the requirements of the country. In this collection were noticed some of the English varieties of wheat, viz: "Chiddam," "Hallets," "Pedigree," grown near Christiana, latitude 59° 55′; also "Cheriff's Bearded," grown at Trondhjem, latitude 63° 52′; and a specimen of California, raised in latitude 59° 40′. There were also specimens of spring and also winter wheat, grown in latitudes 60° and 63° 26′, but of poor quality.

Barley is successfully cultivated, even in latitude 70°; the specimens were of fair quality. Rye and oats are cultivated to considerable extent between 68° and 70°. Some very good specimens of corn of the round flint variety were noticed. They were grown in latitude 59° 55′.

ENGLAND.

Under a superior system of agriculture Great Britain has succeeded in establishing some very valuable varieties of cereals. The specimens of wheat, for plumpness, color, and flour-yielding qualities, were unsurpassed. The following named winter varieties of white may be classed among the best in the Exposition, viz: "Chiddam," "Trump," "Grace," "Stumff's Bearded," "Albert," "Australian."

The varieties of red were "Hallet's Pedigree," "Lammas," "Nursery," "Cheriff's Bearded."

Great attention has also been given to the cultivation and improve-

ment in the quality of oats, barley, and rye, and the specimens in this collection embraced some of the best varieties in the Exposition.

The colonies of Great Britain were well represented in the agricultural department.

AUSTRALIA.

This colony excelled all others in the variety and richness of its cereals, and demonstrated that agriculture has already attained great perfection in that distant continental island, and that its climate and soil are adapted to the cultivation of the best qualities of grain. The specimens of wheat attracted great attention, and were among the finest in the Exposition. The best varieties were labeled "Orange," "White Tuscan," "Purple Straw," "Prolific," "Pedigree." Three specimens were very sound, thin skinned, plump, and of fine amber-white color. These varieties have been introduced into Germany, England, and other parts of Europe, and also into California, with great success.

The specimens of oats, rye, and barley were of very superior quality. The specimens of corn were among the best in the Exhibition, including a sample of white "Bread Corn" of the "Dent" variety, of unusual size; also a specimen of very large yellow flint corn.

NATAL AND BRITISH GUIANA.

Both these colonies displayed some fine specimens of white and red winter wheats of English varieties. Also some excellent samples of corn grown from Illinois seed, which had lost nothing from change of climate. The specimens of barley, rye, and oats were of good quality.

CANADA.

Canada surpassed her American neighbors in the tasteful arrangement of her cereals. The specimens embraced many excellent varieties of red and white winter wheat, and some very fine samples of spring wheat; also some very good specimens of oats, rye, and barley, all giving evidence of an excellent system of cultivation.

FRANCE.

The agricultural department of this country was truly on a magnificent scale, and the display of cereals rich and varied, evincing a very superior system of cultivation. The specimens of wheat embraced many valuable varieties, perhaps more in number than any other country. Among those most worthy of notice, of the white winter variety, were labeled as follows, viz: "Géant," "Mungowell," "Chiddam," "Blé Blanc Géant." The red and amber were as follows, viz: "Blé Rouge d'Espagne," "Rouge d'Ecosse," "Hallett," "Pedigree," "Blé Ambre Gloire." The above named may be considered among the best producing and milling wheats. There were also some good varieties of spring wheat; one specimen of white spring named "Chiddam de Mars,' a very good,

plump, thin-skinned wheat, of good color, said to produce forty bushels to the acre; another sample, labeled "Blé de Saumon de Mars," a fine amber-colored wheat; one other specimen, marked "Blé de Mars Ordinaire," a very good variety. The introduction of some of these varieties into the United States would undoubtedly prove a valuable acquisition.

The specimens of corn were mostly of the round flint variety. A few fine ears of this cereal, grown from Illinois seed, were noticed in the collection. The samples of barley, rye, and oats were numerous and of good quality.

ALGERIA.

This colony of France made a very marked and interesting exhibition of its agricultural products, including fruits and cereals. Nearly two hundred specimens of wheat were in this collection, most if not all being of the "*dur*" (hard) variety—a peculiar, long, rough, flinty, amber-colored berry, of unusual size, many of the kernels measuring nearly half an inch in length. There were also some specimens of white, of the same variety. All the samples were very pure and in fine condition, giving evidence of a good system of husbandry.

The specimens of oats were very superior, particularly one of red color, not found in any other collection, and a fine variety. The corn was the round flint variety; the barley was large and heavy, and of good color.

DENMARK.

The specimens of cereals of various descriptions from this small but very fertile kingdom were very numerous, of excellent quality, and were characterized by the remarkable neatness and beauty of their arrangement.

BELGIUM.

The cereals from this country were of very superior character, evincing a high state of cultivation. The specimens of white and red winter wheat included some fine varieties, possessing very desirable milling qualities.

There was but one sample of spring wheat in this collection, which was of very good quality.

Some specimens of very large and fine colored rye were observed. Oats and barley were of fine quality.

PORTUGAL.

The specimens of cereals from this country were arranged with much taste and attracted great attention. The collection embraced the usual varieties of winter red and white wheat, all in fine condition and generally of excellent quality, but not of high grade. The specimens of barley, rye, and oats were of fine quality. The samples of corn were all

of the small flint variety. In this department there were numerous specimens of beans, some of which were of unusual varieties and well worthy of notice.

SPAIN.

The agricultural department of this country was distinguished by its elegance and the variety of its products. The specimens of wheat, with the exception of a few of superior quality, were of the usual type of southern Europe, rough and thick skinned. The specimens of oats, barley, and rye were generally good. The specimens of corn were small and flinty.

CHILI AND ARGENTINE REPUBLIC.

These countries exhibited several specimens of wheat. Two of white winter, from the provinces of Buenos Ayres, were of very good quality; but the other samples were of ordinary character, rough and flinty, evincing a want of good husbandry.

CHINA AND JAPAN.

These countries contributed specimens of their cereals, but at the time the examinations, in view of this report, were being made, the collections were not in proper order for inspection.

UNITED STATES.

In the department of cereals this country should have equaled if not excelled all other nations, but it is to be regretted that the specimens exhibited were not adapted, without a very careful examination, to fully illustrate its great grain-producing capacity. There was a large number of specimens, representing the cereal product of nearly all the States in the Union; but of wheat the *specimens* were too small, and greatly inferior to the average quality usually produced in the States whose names they bore. The inferior quality of many of the samples may be imputed in some degree to the unfavorable season of 1866, but the absence of liberal contributions of our best cereals, and the entire want of neatness and taste in their arrangement, may be attributed, to some extent, to the small degree of interest taken in the Exposition by the several Boards of Trade in our large grain markets. It was in the power of the various commercial institutions to have made valuable contributions to this most important branch of the American department, but unfortunately, with few exceptions, they failed to do so. The Chicago Board of Trade, representing the most extensive grain region in the country, contributed liberally of corn, but their specimens of wheat were intended more for the purpose of illustrating the system of inspection in that market than the general character of this cereal. These samples being without fixed labels were displayed to great disadvantage, and passed with the uninformed as samples of crops; and while "Number one" was considered a very creditable specimen, numbers "two" and "three"

and "rejected" did not elevate the character of our wheat in the estimation of Europeans. The specimens of spring wheat contributed by the Milwaukee Board of Trade, although liberal in quantity and displayed in neatly-made cases, were inferior in quality, and on a fair crop would have barely passed inspection as "second grade." Among this collection of common, poor, and positively bad spring wheats were found some small glass jars, containing about four gills each, of very beautiful wheat of the spring variety, contributed by agricultural societies and individuals in the States of Wisconsin, Illinois, Iowa, and Minnesota. The best of the specimens were labeled "Number 31," "Number 46," "Rust Proof," "China Tea." These specimens, although few, and almost too small to be noticed, really proved, after being placed in a conspicuous position, the redeeming feature of this description of wheat in the collection, and demonstrated that the country possessed some of the finest varieties of spring wheat.

In winter wheat there were numerous and varied specimens from nearly every part of the country, including many excellent milling varieties from the States of New York, Pennsylvania, Ohio, Tennessee, Massachusetts, and Vermont. Specimens of wheat, and also of corn, oats, rye, and barley were contributed by the States of Vermont, Rhode Island, Connecticut, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Georgia, Virginia, Missouri, Kansas, and Nebraska. Many of these samples were of good quality, but generally too small to attract attention.

There is great necessity of improvement in the character of our winter wheats, and this might be effected by the introduction of well-selected varieties from Germany, Austria, England, and France.

California, having suddenly developed and taken high rank as one of the great food-producing and exporting States, contributed several liberal specimens, from one to two bushels in each, of wheat originally grown from Australian seed of the "White Tuscan" variety, being unsurpassed in color, weight, and plumpness by the best samples of Australian, and deserving the highest award of the judges of the Exposition.[1] Allusion has been made to the successful cultivation of

[1] The rapid increase of production of wheat in California is convincingly shown by the following statistical information, compiled from "Carmany's Commercial Herald and Market Review." It will be seen that this State, which a little more than ten years ago was a large importer of breadstuffs, now exports large quantities of cereals to England, Australia, and the domestic ports.

During the year 1868, 465,463 barrels of flour, valued at $2,976,765, and 4,072,108 centals of wheat, valued at $8,635,343, were shipped from San Francisco. Reduced to the basis of wheat, these exports amount to 5,468,497 centals, valued at $11,612,108. During the last half of the year 1867, one hundred and nineteen vessels laden with wheat were dispatched from California. During the corresponding period in 1868, one hundred and thirty-one vessels laden with wheat were sent off. For the last quarter of the year 1868 there were sixty-eight whole or partial cargoes of wheat cleared, thirty-eight of which were for Great Britain and seventeen for domestic Atlantic ports. For the corresponding quarter of 1867, fifty-three cargoes of wheat were dispatched,

this description of wheat in Northern Germany under the name of "Kalifornischer Weizen," and even in Norway, where it is grown, in favorable seasons, in latitude 59° 55′ with but little deterioration. This wheat might be cultivated in our middle and southwestern States to great advantage, where the humidity of the climate would overcome that dryness which is produced by the peculiar meteorological condition of the Golden State.

Specimens of the great national cereal corn were contributed from nearly every State between the Atlantic and Pacific. The finest were

the same aggregating 1,153,258 centals, valued at $2,713,943. Included in wheat clearances for 1868 were ninety-seven cargoes for Great Britain, forty-seven for domestic ports, and twenty-two for Australia. The wheat shipments for the last quarter of the year amounted to 1,503,000 centals, valued at $2,839,000.

Receipts of flour and wheat at San Francisco for ten years ending in 1868.

Year.	Flour.	Wheat.	Equal to barrels of flour.
	Qr. sks.	*Sks.*	
1857-'58	141,825	243,052	116,474
1858-'59	274,216	433,002	212,888
1859-'60	365,628	985,026	419,749
1860-'61	455,115	2,160,723	834,020
1861-'62	426,260	1,361,218	560,304
1862-'63	638,353	1,864,652	781,138
1863-'64	402,408	1,846,118	715,975
1864-'65	242,601	474,207	218,719
1865-'66	676,607	2,127,069	878,175
1866-'67	1,166,793	4,851,915	1,909,003
1867-'68	795,719	4,904,255	1,833,681

The receipts of flour and wheat from Oregon for the year 1868 were equal to 154,503 barrels of flour.

The following table shows the exports for ten years:

Exports from San Francisco for ten years.

Year.	Flour.	Wheat.	Equal to barrels of flour.
	Barrels.	*Sks.*	
1857-'58	5,387	3,801	6,654
1858-'59	20,577	123	20,618
1859-'60	58,926	381,766	186,182
1860-'61	197,181	1,529,924	707,156
1861-'62	101,652	851,844	385,680
1862-'63	144,883	1,043,652	492,727
1863-'64	181,102	1,071,292	541,199
1864-'65	77,501	30,309	87,604
1865-'66	256,657	1,055,830	607,600
1866-'67	485,339	3,639,625	1,698,547
1867-'68	429,237	3,758,684	1,682,132

EDITOR.

from the fertile prairies and valleys of the Mississippi. Cornstalks measuring sixteen feet in length, loaded with splendid grain, enormous ears filled to the tips with beautiful yellow corn, were in great profusion, and excited the admiration of Europeans. With the exception of Australia, no other country exhibited specimens of corn that would at all compare with that from Illinois.

Of barley, rye, and oats there were some good specimens of each. The "Surprise" oats from Wisconsin were among the best in the Exposition, but there is obvious necessity for improvement in these grains. The rye and barley were inferior to many European varieties.

GENERAL OBSERVATIONS IN CONCLUSION.

The foregoing pages enumerate and describe, so far as may be necessary, the cereal contributions from all the countries represented in the Exposition up to the time of closing this report. It will be found that in almost every habitable part of the world a kind Providence has blessed the soil and climate with the necessary properties for cultivating the "staff of life" to a greater or less extent.

Foremost in the list of edible grains, and most natural to human sustenance, is wheat. Its history runs parallel with that of mankind, and its consumption in the form of bread has ever increased and gone hand in hand with civilization and refinement. The cereal product of the world, although always sufficient probably to supply the hungry mouths of its inhabitants, seems, like its population, unequally distributed—here a surplus, there a deficiency, and again a positive want of bread. In many of the densely populated parts of Europe the product is barely sufficient to supply the consumption; in others, a large annual deficiency must be provided for. A short crop is often attended with the most serious commercial and political difficulties; hence the question of "bread" becomes vitally important. There is, however, always a compensation in the surplus of other countries, as it is rarely or never the case that universal scarcity or famine prevails in all the food-producing districts of the world at the same time.

The countries which may be considered the great producing sources of supply are Russia, Germany, Denmark, Turkey, Egypt, France, Austria, Spain, Italy, Portugal, and the United States. These countries export more or less, in seasons of plentiful crops, to their neighboring nations in Europe, but some of them are frequently compelled to import largely for their own use. England, with her prolific fields and splendid system of agriculture, has a positive, permanent, and increasing deficiency of supply.

The important question of the comparative capacity of the different nations of the world to supply the cereal food which the world requires arose so naturally out of the visible exhibition at Paris of the cereals of the world, that the commissioners of the United States deemed it worthy to be separately examined and made the subject of a separate report.

They accordingly committed to the vice-president of the United States commission, Hon. Samuel B. Ruggles, the duty of collecting at Paris and elsewhere, and of presenting in condensed form, statistics of the production of cereals of every description in the various countries of Europe, to be accompanied by information in respect to the facilities of the different nations for transportation, and such information, also, upon the commercial movement of cereals among the leading nations, as might be useful to the United States of America.

It may be predicted that the result of the proposed examination will show, what indeed has been already largely taught by the experience of the business world, that in competing for the supply of the English market the most formidable rival of the United States will be Russia. Possessing a vast territory, extending from Archangel to the Crimea and from the Baltic to Siberia, unsurpassed in fertility and diversity of soil and climate, the product of that country is now only limited by imperfect cultivation and the want of canals and railroads to transport her grain to market; but Russia is becoming a progressive nation, and with increased facilities and cheap transportation for moving her crops we may look for a stronger and more determined competition than now exists.

The United Kingdom being the great and only reliable market for the surplus wheat and corn of the world, and in view of the impending competition that we are to meet in that market, it becomes expedient that the producers of the United States adopt the most perfect system of cultivation and preparation of their cereals to meet the demands of this commerce. At present we have the advantage, to some extent, in the means for moving our crops rapidly from the places of production to the seaboard. Our system of agriculture, preparation of grain for market, and the quality of our grain, surpass the Russian; but these advantages are only temporary, and will avail little, unless we take active measures to preserve whatever pre-eminence we may have already obtained in this trade. We must encourage a higher system of agriculture, and a better selection of seeds with regard to soil and climate. Many of our farmers sow imperfect grain, which in turn produces weak plants and a diminished product. We should encourage the introduction and culture of new varieties of cereals from European countries. We should increase to the utmost and enlarge our channels of communication, and cheapen the cost of handling and transportation of our great food staples, for the *cost of transportation* from the producer into the hands of the consumer is the vital part of the whole question of supply.

Spring wheat, being a more reliable crop, is cultivated to much greater extent than other varieties; it is the popular commercial variety, and predominates largely in our exports. It is not assuming too much to say that the average quality of our spring wheat crops is greatly superior to those of any other country. This is an important advantage, but without proper care it may be lost, as it is an established fact that the quality of the best varieties of wheat is in constant process of deterioration.

Quality and variety, as well as superior merchantable condition, being essential elements to commercial pre-eminence in this trade, it is of great importance that our producers and dealers should co-operate in preserving and improving the character of wheat and all other cereals which enter into the foreign commerce of the country.

It is to be hoped that the general government may adopt a more efficient and useful method than has heretofore existed for the introduction and culture of new and valuable foreign varieties of cereals. With superior varieties of grain in good marketable condition, and cheap transportation, we shall be able to compete successfully with the most formidable rivals in the markets of the world; and, with remunerative prices, we can extend further and further into our great national granary until that immense territory shall pour forth its millions on millions of cereals to gladden and bless the nations of the earth.

Respectfully submitted.

GEORGE S. HAZARD,
United States Commissioner.

BUFFALO, N. Y., *December*, 1868.

PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

ON THE

PREPARATION OF FOOD,

BY

W. E. JOHNSTON, M.D.,

HONORARY COMMISSIONER.

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PREPARATION OF FOOD.

The Great Exhibition of 1867 contributes certain facts to our stock of knowledge on the preparation of food which are well worth the attention of the public. It is not certain that in the modifications we will have to observe much improvement has been made in a hygienic point of view; we are inclined to believe, in fact, that they are rather gustatory than hygienic—rather for the palate than for assimilation and the creation of healthy blood. But they are nevertheless advances on old systems of preparation, and therefore demand a notice at our hands. Whatever is new, and especially whatever is likely to differ from modes of preparation in the United States, will naturally occupy the largest space in these observations.

CAFÉ RESTAURANTS.

The Imperial Commission certainly had a happy thought in introducing café restaurants as an element of international competition. The realization has not in fact corresponded to the anticipations of the commission, for criticisms have not ceased to fall upon the project from the beginning to the end. The idea of giving the largest and most prominent place to the eating-houses was the first and most prominent point of attack, and one could not, indeed, at the first sight of an arrangement which spreads the kitchen out over the extended circumference, and hides the fine arts away in the contracted centre, refrain from an expression of astonishment at the plan of a temple of civilization which presents the stomach before the head. But the Imperial Commission comprehended better than their critics how much inportance the majority of mankind give to the material necessities of life, and it is thus that we find the kitchen in this great international tournament in the place of honor.

It may be said in a general way in regard to competitive cooking, that whatever is common to all is pretty sure to be good, and that whatever is peculiar is pretty sure to be bad. If it shows us nothing else, the outer circle of the Exhibition at least shows us how badly some people live, and this is not without its value. But climacteric influences require, or at least lead into peculiar modes of preparing food, and it does not at all follow that these peculiarities may not be sometimes adopted with advantage by others. The human system is the most amiable of divine creations, and accommodates itself by the force of habit to things the most opposite. The Esquimaux are pushed to the eating of blubber by the necessity for a large combustion of carbon in their

bodies; but a man living under the tropics may also drink and thrive upon cod-liver oil, and perhaps even upon blubber. So, too, we see at the garden of acclimation of Paris the animals of the most opposite climes, by care and by force of habit, made to live and to thrive together.

It is nevertheless to be regretted that the café restaurants, although so admirably placed for the purpose, did not attempt to enter into an international competition, and that they did not reclaim nor obtain even an honorable mention. By aid of the monopoly granted they appear to have entered into no other competition than that of high prices; they perfected nothing but the art of selling dear their mediocre merchandise. After all it was not perhaps the fault of the proprietors; their rent was high, and they were obliged to make money. Yet we expected and should have been treated to a series of grand competitive feasts, in which our palates should have been called to sit in judgment upon all the rareties of these modern times—upon all the latest caprices of the gourmand. We had anticipated being called upon to taste horse, dog, and bear, swallows' nests, sharks' fins, fish-worms, grasshoppers, and sea-lions.

When we come to specify, we find that the American restaurant of Messrs. Dows and Guild was in no sense a success, nationally, in its eating department, and so far as it was a financial operation would have been better left at home. But the ice cream sodas of this establishment were one of the successes of the Exhibition, and will remain behind. Mr. Dows has taken out patents for the shaved ice employed in the manufacture of these delicious beverages, and there is already a certainty that they are to obtain a wide extension in Europe.

The English restaurant of Messrs. Spears and Pond appears to have been the best financial success of any, and when asked upon what feature of their enterprise they based this success, they replied that they hardly knew, unless it was to the fact that they published their prices and stuck to them. They nevertheless did a large business in "lunches," and they sold enormously of English ale and sherry wine. Their hams and liquors were brought from England; but their beef, mutton, and poultry were French, and they found them quite good enough for an English table, when properly cooked. I am inclined myself to attribute their exceptional success largely to the simplicity and general excellence of the English kitchen, which is thus suited to the digestion of travellers timid about their health.

The French restaurants are said to have lost money. They were organized like similar establishments in the city, and did not claim to present anything new to the public.

The Russian restaurant was successful financially, and made itself a name with its exotic food. It became famous for its *caviar*, its tea, its smoked salmon, its high prices, and the national costume of its waiters.

Of all the other national restaurants of the Exhibition, the omnibus eating house for the poor, noted only for its economy, and the Viennese and Munich café breweries, appear to have done well.

THE BAKERIES AND THEIR BREAD.

I come now to speak of something of more importance. The Austrian flours, the mechanical bakery of Messrs. Vaury & Plouin, of Paris, and the Viennese bakery of Mr. Vanner, have made a veritable sensation at the Exhibition, and mark a real progress in the manufacture of bread. The flours of Austria, and the mechanical bakery, were rewarded with gold medals; the bakery of Mr. Vanner received only a silver medal. The crowds that constantly assailed these two bakeries showed the importance that was attached to them. No two competitive systems could have been more fairly placed before the public, or with results more positive.

The building erected by Messrs. Vaury & Plouin, of Paris, in the Park of the Exhibition, is 50 by 30 feet, and two stories high. The cost of the building, machinery, and installation was about $15,000. The loss to the proprietors, on account of the short duration of the Exhibition, will be considerable. The establishment requires thirty employés. It contains a granary, a fanning-mill, a grist-mill, several mechanical kneading machines, a machine for cutting the dough into the various formed rolls and cakes, five baking ovens, and the engine that puts the whole in motion.

There is nothing peculiar in the engine; any engine may be employed that is sufficiently powerful to propel the machinery.

The grist-mill possesses no new features; it is simply as perfect a mill as can be constructed, and turns out a very superior flour.

The dough-kneading machines are several in number and of various forms, but all have been discarded but one, M. Vaury informs me, the superiority of which has been established in great part by the present enterprise. The discarded machines are mostly oblong, like troughs, with the kneading wheel turning through their whole length.

The kneading apparatus definitively adopted as the best by M. Vaury, and which appears to be adopted generally with but little modification, may be described as a large, flat, iron kettle, two feet in depth, six feet in diameter, and perfectly circular, the middle so filled up with the box through which the turning shaft moves as to leave a circular trough for the kneading process only about sixteen inches wide. In this trough the two wheels turn which are to knead the dough, affixed at opposite ends of a horizontal shaft, like the wheels of a steamboat. These wheels are open, elliptical pieces of wrought metal, with points bent upwards to catch the dough. Half way between them on one side there is a horizontal wheel with upright paddles, which performs the duty of constantly pushing the dough back to the kneading wheels. With these open kneading wheels the dough is rapidly turned and returned until fit for baking. A mass of several hundred pounds of dough was thus sufficiently worked in my presence in seven minutes.

The machine for cutting the dough into cakes is a cylinder covered with forms in zinc, which forms, in passing under the gallery of a hopper filled with dough, catch the dough, give it their shape, and then

throw it out on receiving boards. It does its work with such rapidity as to be required only at long intervals through the day.

Thirty thousand rolls and crescents are sometimes kneaded, cut, and baked, in the establishment of Messrs. Vaury & Plouin in one day. The capability of the ovens for baking is entirely out of proportion to the capabilities of the various machines for preparing the dough; but the capacity of the ovens cannot be increased without a too serious increase of expense.

The construction of the ovens is of primary importance; several innovations have lately been made, of which the most recent and most remarkable is the introduction of steam into the oven while baking. The ovens of this and all good modern bakeries are made on an inclined plane, with the floor running up from the mouth at as sharp an ascent as the dexterity of the workmen in placing the loaves will permit. The ovens of Messrs. Vaury & Plouin have an inclination of about eight degrees. This ascent favors the establishment of a current of heat, which is better than stationary heat, and it also promotes the circulation of the steam, which is now universally introduced into ovens, near the mouth, while the baking is going on—an improvement which adds materially to the beauty and quality of the bread. In fine, to finish the description of the ovens, their mouths are placed low down so as to prevent the escape of steam or heat, and their domes are made in a flat arch as heretofore. Such is the description of the mechanical part of the much admired establishment of Messrs. Vaury & Plouin.

As for the composition of the dough, it is not pretended that there is any material improvement; it is simply a question of good flour, good yeast, good milk, good butter, and good workmanship.[1]

[1] The following is the formula of a very superior baker as written out by himself: "I employ any first quality of flour, first quality of milk; new Schiedam (Holland) yeast, without mixture. To 200 pounds of flour I put 60 quarts of milk, (75 litres of milk to 100 kilograms of flour.) I then mix about three-fourths of the flour with the milk very lightly. I beat this well until it contains large bubbles of air. I then add the yeast, (about seven quarts soaked in the 100.) I afterwards work in insensibly the rest of the flour, and when the dough is well out of the flour, *I beat it constantly on itself*, until finished, taking great care that it does not get warm. I then take it out of the trough to weigh it. The weigher must be a quick operator, as also the turner. Two masses are weighed at a time, and the turner divides them again in two with the under side of the palm of the hand, the thumb being held close. The pieces are then placed in the moulds, which ought to be well powdered with saxogene or *bouquette*, (flour.) One is turned in each hand. They are then placed in a cupboard or on a shelf in proximity to the oven, in a temperature more elevated than that of the dough, and covered with linen. They are here left to the operation of fermentation, but not too long. When the process of fermentation, which varies in time, has gone on long enough, they are placed in the oven to bake. They are first powdered on the bottom with saxogene. They are then put into the furnace, (which is seven inches high,) one at a time, commencing below and going up till the furnace is full. They are allowed to cook if the oven is very hot 20 to 25 minutes.

"In making the dough the milk is heated in proportion to the temperature of the flour.

"The yeast is simply a compressed and dried composition made from the distillation residues of juniper berries, or schiedam.

"I do not speak of the oven in detail because it is adapted to the kind of baking required."

Mr. Vanner, proprietor of the Austrian bakery, prefers his work done by hand. His bread is adjudged to be the best of the Exhibition, and the majority of travellers speak of the Vienna bread as incomparably superior to all others. I was naturally anxious in the beginning of my investigations to know Mr. Vanner's secret, but I soon found that he had no secret at all. He declares that the superiority of his bread is due to superiority of flour and of materials, and to careful methods of manufacture. He believes, and this point is conceded, although French manufacturers of flour were rewarded with the same medal, that the Austrian and Hungarian flour is the best flour in the world, and *contributes the most important part* to the excellence of his bread. He uses, it is true, the yeast of Fanta, of Vienna, and believes it to be the best; but whether best or not, it requires more watching and more care than the Holland yeast. Mr. Vanner's oven resembles the improved oven of the French mechanical bakery of Messrs. Vaury & Plouin, only that the floor has more inclination. He introduces steam into the oven while baking, the same as the French, so that all his bread is cooked in a thick atmosphere of vapor. Mr. Vanner arrives at his magnificent results, therefore, by the superiority of his material, and by a careful and laborious and intelligent manipulation of them. His secret goes no further than this.

If we turn back now to the mechanical bakery, and make a comparison between the two systems—between the laborious hand system of Mr. Vanner and the majority of the bakers of Paris, and the rapid mechanical system of Messrs. Vaury & Plouin—we find:

1. That the machine-manufactured bread is inferior to the hand-worked Vienna bread, and also to the hand-worked bread of the majority of French bakers.

2. That, on the other hand, while the hand-working system is costly in the great consumption of time, the machine-worked bread is cheap.

3. That the bread worked by hand is subject to inequalities in excellence, on account of the more or less want of attention of the workmen; whereas in the machine-worked bread these inequalities may never exist.

4. That, therefore, both systems are good—the one for *pains de luxe*, or fine bread; the other for good, ordinary bread, and for cheapness, for promptitude, and great rapidity.

I should add that the general sentiment of the bakers in regard to the mechanical bakery is that it is susceptible of a higher perfection than that yet attained; that it is destined to universal adoption; and that, although hand-worked bread may still continue to be made for those who prefer it and can afford to buy it, the machine-made bread is already sufficiently perfect for ordinary uses, and ought to be encouraged.

On the subject of yeast I have only to state that the bakers of Paris use exclusively that made in Holland, of which large depots are to be found at Paris, whereas the Austrian bakers use the yeast of M. Fanta, of Vienna. The reputation of the Vienna bread has become so universal,

and the desire to imitate it so great, that the Vienna yeast has been put on sale at Paris, and comparative experiments between it and the Holland yeast are now being made by the Paris bakers.

After saying this much of the comparative modes of baking, and of the ameliorations which have been introduced into this important industry, I am compelled to state that in the opinion of the medical world this very fine flour and fine bread are not favorable to digestion and assimilation; in other words, that although there is an evident progress in a mechanical point of view, there is none or worse than none in a hygienic point of view; and that if we look at the question in this more practical light, our enthusiasm for the inventors must be singularly moderated. We see in effect that birds swallow whole grains of corn, and then follow them with pebble stones to grind them; and digestion is too similar a process in all bodies to be ever exactly opposite. Every one in effect knows the benefit derived in cases of weak digestion from whole mustard seeds and from bread made from unbolted flour. The infinitesimal division of the flour and its perfect bolting, which constitute the secret of excellence in the Austrian flours, create acidity of stomach and tend to indigestion. The improvement, therefore, which I have noted is, as mentioned in the first part of this report, gustatory rather than hygienic, and must be passed rather to the account of art and luxury than to that of utility.

In France dyspepsia is extremely rare; in America every second man is more or less dyspeptic. The causes of this frequency are: miasmatic influences, (which derange the liver,) bad cooking, hasty eating, hot bread, the abuse of liquors, and the excessive use of liquids. In France there is no miasmatic influence to derange the liver, the cooking in general is good, no one eats hastily, hot bread is regarded as a poison, no one abuses strong liquors, and but little water is ever drunk. To these happy aids to digestion in France ought to be added the benign influence of the common table wine of the country, the wine which contains not more than from 8 to 12 per centum of alcohol. This kind of wine is certainly strongly tonic, and, according to the opinion of Frenchmen, its regular and regulated use renders men more vigorous, more intelligent, more sociable, and more sober. The curse of drunkenness is only observed in the geographical zones and the social strata where wine is only drunk by exception. The man who is able to find on his table every day at dinner and supper half a bottle of red wine has no need of going to the tavern or the drinking saloon. But these remarks apply only to the red wines of France, to the wines of daily use, the wine which sustains while quenching thirst, the wine which is, in fine, the real comrade of bread. The wines of Spain and Portugal intoxicate and brutalize, but neither quench the thirst nor satisfy any reasonable desire of the body; the wines of western Germany create acidity and thirst, and are, therefore, in no sense hygienic. It is only the red wine of France which is both moral and logical, and fit for the daily use of every man.

The system of bread-baking and bread-eating in France reposes on the idea that bread should be eaten in from four to twenty-four hours after baking. It should be cold, and good enough to be eaten even by invalids before it is stale. No bread is made in the family kitchen, and there is no such thing as hot short cakes, hot corn bread, and hot buck-wheat cakes. It is always the same monotonous, but excellent, cold roll, or *flute*, from year's end to year's end. It is a fundamental article of faith that bread, to be wholesome, must contain as much outside, or crust, as possible, and for this reason we see no "family loaves," as in England and America; nothing but the eternal single loaf, suggestive of economy, and of that life of individual isolation which forms such a desolate feature in the every-day history of Paris.

FARINACEOUS PREPARATIONS.

The flour of Austria took the highest rank at the Exhibition. The jury awarded to the French manufacturers a medal of gold, the same as to the manufacturers of Austria; but the bakers and the public did not hesitate a moment in giving their judgment in favor of the Austrian flour. The Austrian system of manufacturing will be introduced at once into France, and will prove a money-making enterprise to whoever will introduce it into the United States; for, however inferior it may be in healthful qualities to the coarser flour, it will yet always command a large sale as an article of luxury. The system of manufacturing as pursued in Austria must, we are told, be seen to be perfectly comprehended, and any one desirous of adopting the system of that country must study it on the ground.

If we consider flour on principle as a question of hygiene, independent of what the public demands, we should say that the best system of grinding was that which *disaggregated* the round and regular molecules of the grain of wheat without *pulverizing* them. Not only is the flour better which is composed of separated instead of crushed particles, but to separate them is the easiest, the most elementary, and the cheapest mode of grinding. *Both science and practice condemn the crushing process*, and yet this process remains the most in use. To the quality of the grain is due, in the first place, much of the quality of the flour. The bakers of the present day prefer flour made from white, tender wheat, because it makes whiter bread, and as this wheat is easier ground than the harder kind of wheat, the miller also prefers it. But the baker loses by it, because this very white flour contains less gluten, and therefore produces less bread. The public also lose by it, because it is less nutritious, less rich in alimentary principles, and more of it must be consumed to produce the necessary amount of nourishment to the body. The fact that the hard grains of wheat are richer in gluten than the white and tender grains is admitted by science and verified by practice. And, so far as France is concerned, this demand of the millers and bakers for the white, tender grain has almost excluded the better grain from

agriculture. So too we hear often in France in these days of the wheat being frozen, an accident scarcely heard of at a period when the harder grain was more in vogue.

Is it not strange to see empiricism invading so serious and so positive a matter as that of the culture of wheat and the manufacture of flour? We have a right to be surprised at seeing fashion and speculation creating habits in this, exactly as in the trifling affairs of life; at seeing agriculture perverted and deteriorated; at seeing the artificial substituted for the natural. The public has thus been taught to prefer a bread made of starch, perhaps even heightened in its whiteness by alum and the sulphate of copper, to a natural and savory and healthy bread, with plenty of gluten and nourishment and life in it, because the latter is not so pleasing to the eye.

The thing to be avoided, therefore, is the system of grinding, which deteriorates the gluten, *the meat of the wheat*, which is thus made to pass off in the form of acetic acid. We must avoid producing a flour simply for the sake of its whiteness and beauty, which, when made into bread, is tasteless, laxative, and brittle, and which dries up in a few hours to a crust. We must avoid a system of grinding which requires, in order to attain the necessary attenuation of the flour, that the stones should almost touch, thus heating the flour and even requiring that it should be wet. We must avoid this system of excessive fineness because it is both costly and useless.

I should say finally that what we want is: 1. A hard and hardy glutinous grain like that of Hungary; 2. A system of grinding which leaves the round granules of the grain of wheat separated but not crushed; 3. The Vienna system of baking, which unites to superior materials of all kinds an excessive care in all the manipulations of the bakery; 4. The modern oven described above, and which is a great improvement on the ancient oven. I should add that the mechanical bakery will be found indispensable for the rapid and cheap fabrication of ordinary bread.

GLUTEN BREAD.

The gluten bread employed in the hospitals of Paris for diabetic patients is manufactured as follows: Take of gluten flour two pounds; of fresh yeast the size of a filbert, mixed with a little cold water; of kitchen salt two pinches. Mix, and then add of warm water, at 35 to 40 degrees centigrade, a sufficient quantity to make a dough of a proper consistency. Then place the dough for an hour and a-half to two hours in a place warm enough to operate the fermentation, cut it into cakes, roll them in gluten flour, and bake them in the same way as ordinary bread.

MACCARONI.

Italy, Algiers, and France, produce the best specimens of this useful and healthy alimentary preparation. As in bread so it is here; the yellow, highly glutinous varieties, are superior in savor and nutritive

qualities to the white, starch-like varieties. There does not appear to be any particular improvement in the fabrication of the various *pâtes alimentaires;* the improvement is more in the extension of the form than of the substance. One's knowledge of mathematics is put to route by the multiplicity of forms the fabricants of these articles have attained. These dough preparations, although not an essential article of diet, are yet highly useful, because good and healthy, and because they add another to the list of articles which may be kept safely in store for table use.

Of the other farinaceous preparations the one which has attracted most attention is the American maizena, of Duryea, an article which needs no description here.

CONCENTRATED MEATS.

A certain sensation has been created within late years, I might almost say within the last year, by the various successful experiments in the concentration of meats. We begin to see now what must have been in former times the sufferings of communities, and especially of caravans and of sea-faring people, by the ignorance which prevailed on the modes of preservation of food for long voyages. We can imagine what privations were entailed on a whole community by the ravages of those epizootic diseases which sometimes swept away the entire race of cattle, leaving behind no meat subsistences for the consumption of the people. If we come down to our own day we can recall to mind terrible sufferings which have passed under our own observations from scorbutic affections, caused by the want of fresh food, or of meats preserved otherwise than in salt. Vaccination and mercury and quinine have saved thousands of human lives, and the world is grateful for the discoveries; so too the world is grateful for those discoveries of science which protect the navigators of the present day from the frightful diseases which ravaged the ships of Christopher Columbus and the bold navigators of the early day. We know now, thanks to the discoveries of science and to the incessant progress of chemistry, that the decomposition of meats and vegetables may be suspended almost indefinitely, that fish as well as game, that peas or asparagus as well as beef or mutton, may be consumed, with pleasure to the palate, several years after being killed or gathered.

The most important of these preserved articles of food is unquestionably the concentrated meats. It is not worth while to discuss here the question of priority in this progress, nor to indicate the various steps gone over before arriving at the present perfection. We have before us at the present Exhibition the most precious and the most remarkable of all the results thus far attained in the *extractum carnis*, the extract of meat, of the distinguished chemist of Munich, Professor Liebig. The history of this industry is well known. In South America, where cattle are killed in masses simply for the hide and tallow, Prof. Liebig sought and found a proper field for the profitable working of his discovery.

By his process the meat is deprived of both its gelatine and its fat. Forty five pounds of beef is reduced to one pound of extract. Of this extract a teaspoonful will make four bowls of soup. Boiling water and salt are all that are required for the operation. The preparation of Liebig, after many trials, proved itself the strongest in its concentration, and as far as is known is believed to be the most completely inalterable in all climates and under all conditions of exposure. French war vessels have carried it through the tropics without any special care, and without any signs of fermentation.

Quite a number of specimens of concentrated beef were exhibited by other inventors, one of the best of which bore the mark of Borden & Currie, of Illinois. Another superior specimen bore the mark of Whitehead & Co., of Australia. The French and English exhibit many specimens, and this commerce bids fair to assume in a short time very large proportions.

It is incontestible that these concentrated meats are destined to render an immense service. Wherever it is difficult or impossible to obtain fresh meat, as, for example, on long voyages by sea, or in caravans, or in armies on rapid marches, or for the cavalry service, or for hunting parties, this new, compact, simple, and excellent alimentary preparation must come into general use.

As for invalids, especially those laboring under acute disease, these concentrated meats can never take the place of the ordinary beef soup and beef tea, because neither their flavor nor their taste are so tempting to the week and nauseated stomach. A very sick man will always be found to prefer the old fashioned beef tea, if well made, to the soup made from Liebig's, or any other form of extract of meat which has yet been offered for public appreciation.

The alimentary department of the Exhibition is rich in products of all kinds preserved by reduction in a vacuum, or by desiccation and compression, for a prolonged use. These processes apply alike to meats and vegetables, and are so well understood and so generally adopted as to require no particular description in this place.

Those articles which have attracted the most attention are the concentrated meats to which I have just referred, and a specimen of preserved flour, seven years old. The value of this last discovery cannot be overrated, for by it many a famine may be averted. The nutritive value of a flour is estimated ordinarily by the proportion of gluten it contains. Good flour contains 30 per cent. of humid gluten. The preservation of the flour consists, therefore, in converting these 30 hundredths of humid gluten (which is a highly fermentible matter) into 10 hundredths of dry gluten, which, later on, when desired for use, recovers, by being wet, all its primitive elasticity. The flour must be desiccated without being altered, and care must be taken afterwards to protect the disengaged particles of starch from the influence of heat and humidity. The grand problem of the preservation of flour is thus resolved, and the honor of it belongs to M. Touaillon, a large manufacturer of flour near Paris.

M. Gentil, of Mans, in France, claims and is awarded the honor of a new method of cooking fish for preservation. He applies hot air and the metallic bath to the boiling of the oils employed by the manufacturers of preserved aliments, and for the cooking of fish of all kinds. That is to say, the direct and unequal action of the combustible is replaced in this system by hot air, obtained indirectly from the heat of the furnace. There is an economy of oil, the fish thus preserved are whiter, more tender, and of a more regular color than those prepared by the other processes. The progress is claimed as an important one for those engaged in this commerce.

The *Pâté de Foie Gras* is represented at the Exhibition by some of the finest specimens of Strasburg manufacture. This other caprice of the fashionable world is the product of the artificial fattening of the goose. The goose is stuffed to repletion with food for several weeks in front of a fire, and at the end of this time the liver of the animal is found swelled to an enormous size with fat. The liver is then cut up and mixed with fat from the goose, and with truffles and other condiments, and then cooked in a case of dough. Paris consumes annually of this delicious but rich alimentary preparation to the amount of 2,600,000 francs. It comes into market mostly from Strasburg, but is also manufactured at Bordeaux, at Agen, at Perigueux, and even at Paris. We cannot admit that a hypertrophied liver, artificially produced, is a healthy animal product, and we do not believe that the manufacture of *pâté de foie gras* is a commerce to be commended in this place.

TRUFFLES AND MUSHROOMS.

Some specimens of preserved truffles are also exhibited which appear as high flavored and as delicate as the fresh ones just brought into market. Truffles, as the reader perhaps knows, are a fungous growth, the result of the sting of microscopic insects upon the roots of a certain kind of oak tree, in a certain clayey soil, and in a certain district of country. The insect stings the oak root to deposit its eggs, and the fungous growth called truffle is supposed to proceed from a blasted egg. This precious tubercle, the last caprice of the gourmand, is not, therefore, susceptible of cultivation, and all attempts at transplantation have failed. Nearly the whole commerce of the world is supplied from the department of Perigord, in France, but truffles are also found in abundance in certain parts of Africa, and have been found in limited quantities in other parts of the world. Whole trees, with roots, and soil, and growing truffles, have been transplanted to other localities in appearance equally favorable to their growth, but all these attempts at propagation have failed. A successful mode of preservation was, therefore, a desideratum, and for this the epicureans of all countries will be grateful.

Mushrooms are also on exhibition preserved by the same system; but mushrooms are more universal in their growth, and may even be cultivated, as we see by a demonstration in the reserved garden of the Exhibition.

A little mound of manure and alluvial soil, arranged in a particular way, is made to grow mushrooms at will.

COFFEE.

France has a special reputation for the preparation of coffee for the table. It is therefore important that I should refer to the subject in this report.

The grain used in this country comes for the most part from Brazil. The best specimens probably come from Arabia and Egypt, but only in small quantities, and the world hereafter will undoubtedly be supplied for the most part from Brazil. The grains from these three countries are well represented at the Exhibition.

Coffee is prepared in France for the table by a system of distillation in a small quantity of water which is now understood and adopted more or less in all civilized countries. It is adulterated often with chiccory, acorns, gray peas, carbonized beets, roasted rye and barley, and other substances. Economy, of course, is at the bottom of these adulterations, but the pretexts of taste, color, and even of hygiene, are urged with earnestness as an excuse.

But coffee ought to be, and is, drunk alone by those who understand its real hygienic effects. Its use is regarded by those who have well observed these effects as positively conducive to the prolongation of human life. It acts by moderating the force of the circulation. It blunts the biting action of oxygen on carbon. It calms the movement of organic disassimilation, and thus causes to be used all sorts of old materials which otherwise would be hurried too soon out of the body. The sleeplessness it sometimes produces is not a diseased or pathological condition, but rather the establishment of an absolute equilibrium, which reposes the various organs of the body as much as if the eyes were closed in sleep. Its action is not to be assimilated to that of medicinal anodynes, which also retard the circulation and the elimination of elementary particles, for these are followed by an astringency, a nausea, and a collapse, which constitute a pathological condition, and they are, therefore, opposed to health. The great secret of the prolongation of human life is the establishment by healthy means of an equilibrium in the functions of the body, and it is certain that coffee does contribute in a healthy way to this end. It cannot be used in all climates to the same advantage, nor by all persons, nor in indifferent quantities. A careful observation should preside always at its use if we wish to obtain its best effects on health.

CHOCOLATE.

Chocolate is a favorite beverage in France, and the various preparations of this article are well represented, especially in the French section. It is a valuable elementary preparation, worthy of a wider use than it has obtained, but unfortunately subject to the vilest adulterations per-

haps of any other article of table use. The adulterations most frequently are: cocoa exhausted of its butter, colored fecula, oils, and grains. The genuine chocolate of the best fabricants is made about as follows, taking 1,000 as the total figure:

Sugar	485	parts.
West India cocoa	500	"
Vanilla	9	"
Cinnamon	6	"
Total	1,000	"

Good chocolate is sold at Paris at four and five francs the pound. All chocolate sold under these prices is certain to be adulterated. The high price of the genuine article, the facility for frauds, and the well-known fact that these frauds are practiced on a larger scale, are circumstances which operate powerfully in limiting the use of what might become with good reason an aliment of much more general use.

The best specimens of chocolate at the Exhibition are those of M. Menier, the first manufacturing chemist of Paris, and of M. Devinck, the oldest and largest manufacturer of chocolate in France.

SUGAR.

Little is to be said on the subject of sugar if it be not that this precious alimentary product is represented in almost every nationality of the Exhibition, and that each manufacturer is astonished at the perfection of the other. No one product perhaps is so generally and so well represented. The cause of this is, that everything about sugar is positive. For example, there are but two substances from which sugar can be extracted with advantage to the manufacturer, and these are the beet root and sugar cane. These two raw materials defy all competition. Then, again, the modes of manufacture are well understood in all countries; so that it is not surprising that we see such excellent specimens of sugar from countries even where other branches of manufacture have thus far acquired but little extension. The manufacture of this article has reached, especially in the workshops of France, and with the beet root, the last degree of perfection. The rendering of sugar has been carried from 5 to 8½ per cent. of the raw material. There is therefore no further improvement to be sought after; the maximum of extraction with the minimum of expense has been attained.

PROFESSOR LIEBIG'S ARTIFICIAL MILK FOR CHILDREN.

This new important compound, invented by the learned German chemist, is not on exhibition only because it does not preserve well. It has nevertheless been discussed on the outside as one of the new ideas which takes its place in the grand competition of the Champ de Mars, and therefore naturally forms a part of this report. In this compound

Professor Liebig pretends to have found a chemical substitute for mother's milk; his analytical mind and his profound knowledge of chemistry are in some sort a guarantee of its perfection.

But most persons will call to mind the discussion provoked by this imitated milk in the learned academies of Paris, and the condemnations that were there passed upon it. The weighty name of Liebig and the natural desire of men of science to add a new element of life and comfort to those already known, were powerful stimulants toward an unreserved acceptation of the new compound. The astounding developments of mortality among children in France, lately made to the Academy of Medicine of Paris, a mortality which reached the frightful figure of 90 per cent. in certain communes, made men turn their eyes eagerly in every direction for new aids in arresting the destruction. So that in this apparently insignificant question of infantile food we see a grave question of humanity and of political economy, for the increase or decrease of population is a consideration of a primary importance to both statesmen and philanthropists. As communities grow older and become more compact the number of children to be fed by hand increases, and the necessity of new modes of nutrition becomes more apparent.

Of what does Professor Liebig's famous substitute for human milk consist? The following is his process: A half an ounce of wheat flour is boiled with five ounces of skimmed milk until the mixture is transformed into a homogeneous mass; it is then taken from the fire and to it is added immediately half an ounce of cross-spired barley, which must have been first ground in a coffee mill and mixed with an ounce of cold water and a drachm of a solution of bi carbonate of potash, the latter in turn made with eleven parts of water to two of the potash. After having added the barley the vessel is placed in warm water or in a warm place till the mixture has lost its consistency and has become liquid like cream. It is allowed to repose for fifteen or twenty minutes and is then replaced on the fire and made to boil for a few seconds, when it is removed and poured through a strainer of hair or thread, so as to eliminate the fibrous parts of the barley. Before giving the milk to the child it is allowed to settle in order that all the fine fibres of the barley that may remain in suspension may be precipitated.

The artificial milk thus prepared contains, according to Professor Liebig, the plastic and respiratory elements essential to respiration and the nutrition of the body in about the proportion of from 10 to 38 on the 100; and this, still according to Professor Liebig, is the same as human milk. The French professors do not find this statement correct, especially as regards the quantity of life giving principles in human milk, and think that M. Liebig took his milk for experimentation from a woman in a low state of health. They think that normal human milk contains more than from 10 to 38 per cent. of the essential elements of reparation, and that, admitting M. Liebig's idea to be a good one, his *compound* is still unequal in force to the fluid it is intended to replace.

This artificial milk has already acquired a considerable extension in Germany, England, and other countries, and in many localities it is the food furnished by charitable societies to the children of poor mothers, to such as are either obliged to abandon their children or to place them in the nursing establishments by the day. No official reports on the success of this new system of alimentation have yet come to my knowledge; nevertheless, here in France the milk has been tried by Dr. Depaul, professor at the School of Medicine of Paris, on four children of the Foundling hospital, and they all four died, two in two days, one in three days, and one in four days, and all alike with bilious evacuations.

I do not pretend to know whether M. Depaul's experiments were faithfully made or not; M. Liebig says they were not. But certainly no man is more competent than Professor Depaul to make such an experiment, and there is no reason for doubting his good faith. This fatal experiment, however, has been sufficient to destroy the confidence of men of science in France in this new article of food, and it is probable that it will acquire no great extension in this country.

In France people are satisfied in this emergency with cow's milk. *The milk of the cow, with the addition of one-fifth of water and a little sugar, is not only a nearer approximation to human milk, it is the nearest approximation of all.* Why then fly to a doubtful chemical composition, when we have at hand so natural and safe an aliment as diluted and sweetened cow's milk?

Liebig's much vaunted artificial milk must therefore take rank after human milk and after properly diluted animal milk. But like the same professor's concentrated beef, which is highly useful where the natural beef is not to be obtained, so, too, this chemical milk may be useful in the absence of natural human or animal milk.

We do not, however, hesitate to give it rank before the numerous class of farinaceous preparations, which are increasing every day. The chemical composition of wheat flour is such, in fact, that it is not difficult to understand its injurious effects on infantile life. It possesses an acid reaction, and after incineration leaves phosphatic acids, which do not furnish in the process of digestion the quantity of alkali necessary for the formation of blood.

PARIS UNIVERSAL EXPOSITION, 1867.
REPORTS OF THE UNITED STATES COMMISSIONERS.

THE MANUFACTURE

OF

BEET SUGAR AND ALCOHOL,

AND THE

CULTIVATION OF SUGAR-BEET.

BY

HENRY F. Q. D'ALIGNY,
UNITED STATES COMMISSIONER.

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INTRODUCTION.

There was a very considerable display in the Exposition of the machinery and the processes used in the production of sugar and of alcohol from the beet root, as well as of the sugar in its raw and refined state. The most successful manufacturers of France and other countries were represented. There were twenty-three exhibitors from France; three from Belgium; two from Prussia, and ten from Austria. The display of distilling apparatus and of centrifugal machines was very fine. A list of the principal exhibitors will be found at the end of the report.

The report was prepared in Paris, and in the French language, during the progress of the Exposition, by Commissioner D'Aligny, and Messrs. Alfred Huet and Alfred Geyler, civil engineers of Paris, France. Having been imperfectly translated into English, it has since been revised and in part re-written, though the arrangement and the diction have been preserved as far as possible. As, also, the original was a technical description, merely, of the operations for the production of sugar and alcohol from the beet root, some observations upon the growth and importance of this industry in various countries have been added.

EDITOR.

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BEET-ROOT SUGAR AND ALCOHOL.

CHAPTER I.

DEVELOPMENT OF BEET-ROOT SUGAR INDUSTRY.

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HISTORY OF THE CULTIVATION OF THE BEET FOR SUGAR.

The history of the manufacture of sugar from the beet is one of the most interesting and instructive in the annals of industrial arts. Although it comprises a period of little more than fifty years, its growth has been marked by rapid strides, and in many European countries the manufacture of sugar, which had hitherto been considered a monopoly of the tropics, is firmly established, and bids fair to become one of the most stable and productive industries. Founded by Napoleon little more than half a century ago, it was subjected in its infancy to the evils of adverse and hostile legislation. Like other grand creations of that man of genius, however, it survived his downfall; for a long time apparently forgotten, yet still remaining, though in obscurity, in a corner of France, till called to fulfill the destiny for which it was created. At last, however, placed on a more secure footing, this manufacture has been carried on with constantly increasing production at a constantly decreasing cost, till it has assumed its present proportions, and may be reckoned among the most important of European industries.

In 1747 Margraff, a Prussian chemist, read before the Academy of Berlin his memoir on the existence of a sugar in the beet identical with that in the cane. It was not, however, until fourteen years after this that this discovery found its first application. Achard, another chemist of Berlin, republished the discoveries of Margraff, and it is to his indefatigable industry and perseverance that we owe the first practical methods used in the manufacture of beet sugar.

From 1789 to 1796 Achard devoted himself to the culture of the beet

and experiments in sugar-making at his farm at Caulsdorff, near Berlin, at the end of which time, with the assistance of the government, he founded at Kunern, in Silesia, a manufactory which proved to be successful, and was soon followed by the erection of two other similar establishments. This was the origin of the manufacture, which is to-day represented by so many establishments in France and in various parts of Europe.

The results of the labors of Achard were published in 1797. The *Annales de Chimie* in 1799 contained a letter from him in which he described the processes used by him in the manufacture of beet sugar, and the cost of the manufactured article; in the same letter he also forcibly presented the advantages which would result to agriculture by the introduction of this new industry.

The political situation in Europe was at this time singularly favorable to the discoveries of Achard. France desired to be freed from the commercial monopoly of England, and to reduce the high price of sugar which the war with that power had caused.

Experience in France did not, however, confirm the brilliant results which had been announced. The commission appointed by the Institute to inquire into this matter reported the cost of the new product at one franc eighty centimes instead of sixty centimes, the price announced by Achard. Two manufactories which had been established near Paris suspended operations, and by their failure threw great discredit upon this industry, which has achieved its present success only after many years of patient and persistent endeavor.

In 1810 the report of Mr. Deyeux, which was read before the Academy of Sciences, again called the attention of the public to the advantages which would result from the manufacture of beet sugar. Cane sugar had at this time reached an exorbitant price, being three francs per half kilogram, equal to about sixty cents per pound. The attention of the French government was also called to this subject, and some specimens of sugar were presented to the Emperor Napoleon.

The feasibility of the manufacture of sugar from the beet having been established, there needed to be but a favorable opportunity to secure to France the possession of this industry.

By the decree of March 25, 1811, the Emperor ordered that thirty-two thousand hectares of land should be devoted to the culture of the beet, and one million francs were placed at the disposal of the minister of interior for encouraging this industry. Instructions were sent to all the departments, and a new decree, under the date of January 15, 1812, established five schools of chemistry, where the processes used in this manufacture were taught. Two million kilograms of raw sugar were also produced in the four imperial factories from the harvest of 1812.

The manufacture was further encouraged by granting five hundred manufacturer's licenses, and by decreeing that all indigenous sugar should be exempt from taxation for four years.

The political crisis of 1814 was a terrible blow to this new industry, and caused the failure of all the manufacturers but one. In December of 1814, however, under an impost of about three and one-third cents per pound, while that of foreign sugar was five cents per pound, the industry revived. New and more effective methods of manufacture were introduced, and sixty or seventy per cent. of juice was realized, instead of fifty or sixty per cent., the amount obtained by the older processes. The yield of sugar at this time was from three to four per cent., the yield of molasses five per cent., and the cost of manufacture about seven cents per pound. From this time till 1830 the progress made was as rapid as it was great. In 1822 the yield of sugar was about five per cent., and the cost of manufacture five and a half cents per pound. The amount produced at this time in one hundred different establishments was about five thousand tons.

The introduction of steam power had a marked effect upon this industry. In 1836 the number of manufactories was one hundred and thirty-six. Since 1840, though there has been a constant struggle between the cane-growers of the French colonies and the beet-growers of France, the amount of beet sugar produced in France has doubled every ten years.

In 1865–'66 the production of beet sugar had reached two hundred and seventy-four millions of kilograms, an amount more than sufficient to supply home consumption without recourse to the French colonies.

In 1830 the average annual consumption of sugar in France per each person was about two pounds, of which, the beet-sugar manufacture produced about nine per cent.

In 1865 the average consumption was fourteen pounds per each person, the beet-sugar manufacture supplying sufficient for that amount.

The rapid growth and development of this industry throughout Europe forms one of the most interesting spectacles of the present century, and the economic, social, and industrial questions to which it has given rise have attracted the attention and monopolized the labors of the leading minds of the countries in which it has been established. The beet has found its supporters and adherents in the cabinets of kings, the acedemies of science, in agricultural societies and farmers' clubs, in the machine shop, and in the peasants' cottage. No other industry of modern times has so successfully harmonized the agricultural and manufacturing interests which have heretofore been regarded as inimical to each other, or has originated and supported so many subservient and minor interests. The manufacture of sugar has been established and successfully carried on in Prussia, Austria, Russia, Holland, the Zollverein, Belgium, Poland, and Sweden. The total amount of sugar produced in these countries, and in France, is six hundred and thirty thousand tons per annum. Except in the seaboard towns of France none other than beet sugar is used; the same is true also of Germany, none

but beet sugar is consumed in Paris, Vienna, Berlin, Dresden, Leipsic, or Munich.

The average yield of sugar for the past eight years has been over eight per cent., and of molasses about 2.40 per cent.

The reduction of the price of sugar effected by means of the substitution of power for hand labor, and the introduction of new and useful machines and processes is illustrated by the following table,[1] showing the average prices, exclusive of duties of No. 12 raw sugar in Paris from 1816 to 1865 inclusive, omitting the period from 1828 to 1854, during which time the price gradually fell:

Table showing the gradual reduction of the price of beet sugar.

1816	12.5 cents.	1825	9.9 cents.	1858	5.6 cents.
1817	11.6 "	1826	10.3 "	1859	6.1 "
1818	12.1 "	1827	9.9 "	1860	6.1 "
1819	11.6 "	1828	9.9 "	1861	5.9 "
1820	10.8 "			1862	5.2 "
1821	10.8 "	1854	5.8 "	1863	5.2 "
1822	7.8 "	1855	6.0 "	1864	5.2 "
1823	8.6 "	1856	6.4 "	1865	5.0 "
1824	10.3 "	1857	7.6 "	1866	4.75 "

According to the same authority the total production of sugar in the world is not far from two millions eight hundred thousand tons in the following proportions:

Total production of sugar from all sources.

Kind of sugar.	Percentage.	Amount.
		Tons.
Sugar cane	71.42	2,000,000
Beet	22.50	630,000
Palm	5.00	140,000
Maple	1.08	30,000
	100.00	2,800,000

Thus it will be seen that the beet furnishes nearly one quarter of the sugar produced in the world.

A recent French writer thus observes:[2]

"This industry has not failed to perform the promises of its youth, and has justified by its rapid development the most enthusiastic hopes of its founders. France in the possession of the beet has become the fortunate rival of the most flourishing sugar colonies, which she has not only surpassed by the progress made in manufacture, but also in production, which is not inferior in importance to that of the island of Cuba."

[1] *Vide* Beet-root Sugar and Cultivation of the Beet, by E. B. Grant, Boston, 1867, p. 19

[2] M. Dureau, Rapports du Jury International Exposition Universelle de 1867, Vol. XI p. 284.

The same author remarks that in the large increase in the consumption of sugar is to be seen a solution of the difficulties which have existed so long between the cane and the beet-sugar manufacturer, and the eventual harmonizing of these discordant interests. This increase also betokens an advanced degree of comfort and a higher scale of living throughout the entire population.

Political economists recommend the liberal use of this article, and by so doing throw their influence on the side of the consumers, whose interest it is to effect the abolition or great diminution of the imposts and duties at present in force, the proper adjustment of which presents so many difficulties to the statesman.

PRESENT CONDITION OF THE BEET-SUGAR INDUSTRY.

Since the establishment of the beet-sugar industry in 1812, it has spread very rapidly over all continental Europe, and at the present time in most of those countries is placed on a permanent and secure footing. It is to be found in Austria, Russia, Prussia, Germany, Belgium, and Holland, and its introduction into England is seriously discussed. This shows a remarkable change of feeling in that country in regard to this industry, for no other nation was so strongly opposed to the introduction of the manufacture of sugar into France as England, or contributed so much to defeat this object, and bring this industry, then in its infancy, into ridicule.

It is proposed to give a brief account of the present condition of this industry in the different countries of Europe, and to enumerate some of the benefits which have resulted from its introduction.

We will commence with France, for in that country the manufacture of beet sugar is carried on more scientifically and successfully than in any other part of Europe.

FRANCE.

Although the discovery of the existence of a crystallizable sugar in the beet is due to Prussian invention and intellect, yet the successful application of the discovery is due to the genius and perseverance of French manufacturers, stimulated by the assistance and approval of the government, and by that feeling of patriotic pride which finds its expression in the workshop as well as in the battalion. The varied fortunes which beset this new industry have been already noticed. It had spread since its foundation to many places in France, and in 1836 was to be found in active operation in thirty-seven departments, the number of factories being 436, although the production did not exceed 40,000,000 kilograms. The law of 1837 by which a duty of fifteen francs per one hundred kilograms was imposed upon indigenous sugar caused sixty-six manufactories to suspend work, and drove the cultivation of the beet from seventeen departments. It was with the utmost difficulty that this industry could be maintained in the northern departments, a country

where agriculture flourished, labor was abundant and fuel cheap. Subsequently the improvements in agriculture, the establishment of canals and railroads, and the consequent decrease in the cost of transportation caused this industry to be again established in many localities, although the north still remains the principal seat of this manufacture.

The following table from the report of M. Dureau shows the number of factories in each department of France and their production for the year 1866–'67:[1]

Production of beet sugar in France for the year 1866–'67.

Department.	Number of factories.	Production in kilograms.
Aisne	80	39,172,464
Nord	160	77,922,287
Oise	32	16,813,646
Pas-de-Calais	76	35,446,974
Somme	55	24,731,431
Other departments	38	22,767,875
Total	441	216,854,677

"In the department of the Aisne this industry is centered, particularly in the arrondissement of St. Quentins Laon, and Soissons. In the department of the Nord, the arrondissements of Valenciennes, Lille, Douai, and Cambrai contain the greatest number of manufactories, particularly the first two mentioned. In the Pas-de-Calais there are the factories of Arras and Béthune; in the Somme, those of Péronne and of Montdidier; in the Oise, those of Compiègne and Senlis. Although the amount of beet sugar manufactured has largely increased since 1837, the number of factories is less, and but twenty-four departments, instead of thirty-seven, as then, enjoy the benefits of this industry. In the department of the Nord alone can it be said that, with but few exceptions, this industry has attained all that can be attained. The manufactories are numerous throughout the whole department; each commune has three or four establishments, and in some places the smoke from the chimneys of sixteen or seventeen factories can be seen on the horizon."

The following abstract from an article published during the Exhibition shows in a striking manner the importance which this industry has attained in some of the districts of France.[2]

"Official returns show that the arrondissement of Valenciennes produced from 1864 to 1866, 151,096,670 kilograms of molasses, and from 1853 to 1866, 953,520 hectoliters of alcohol. During the same period the sugar factories consumed nearly six milliards of kilograms of beets, a large part of which was produced in the neighboring districts and sent here to be manufactured. The immense plantations of this arrondisse-

[1] *Rapports du Jury International*, Vol. XI, p. 287.
[2] *Exposition Illustrée*, Vol. II, p. 28.

ment, which formerly sent the whole crop to the sugar factories, now send a large part of it to the distilleries, and the great factories and refineries are forced to call upon the neighboring arrondissements for the supply necessary to keep their works in operation. This, however, does not seem to have affected the manufacture of sugar, for the arrondissement of Valenciennes has exported during the last eight years nearly fifteen millions of raw sugar.

"This district contains sixty-four factories which furnish occupation during the winter season, when no other employment can be obtained, to 7,000 men, 2,750 women, and 2,670 children of both sexes. The wages paid to these operatives for the one hundred and twenty days' work, which is the length of the sugar-making season, amounts to 3,250,000 francs. If to this amount is added the sum of 800,000 francs paid for agricultural labor, the sum of 4,000,000 francs is reached, which is paid as wages in this industry annually. The sugar factories produce annually 6,261,000 kilograms of sugar, 1,621,700 kilograms of molasses, and 24,990,000 kilograms of pulp. They make use of numerous steam engines whose aggregate power amounts to one thousand horses. Finally this industry has during the last ten years paid for local taxes the sum of 80,000 francs, while all the other industries of the arrondissement combined have contributed less than 90,000 francs."

In those departments into which the cultivation of the beet and the manufacture of sugar have been lately introduced, the newest processes and best machinery are to be seen. The size and productive power of the factories have generally been increased, and the average production, which in 1836 was 90,000 kilograms per each factory, at the present time has reached as high as 500,000 kilograms, and in some cases, that of the largest establishments, 1,500,000 kilograms. The amount of sugar usually extracted is from 5.60 to 6 per cent. An establishment therefore producing 1,500,000 kilograms of sugar would work up from 25,000 to 30,000 tons of beets, which, basing the production at forty kilograms per hectare, would require from 650 to 750 hectares under cultivation. The average amount of land under cultivation for each factory is from 250 to 300 hectares, which is as much as can be economically worked, owing to the difficulty of transporting the beets to the factory.

The aggregate amount of steam-power employed in this industry is 88,000 horses, estimating a 200 horse-power engine to each factory.

The amount of land under beet cultivation in France at the present time is estimated to be 110,000 hectares. In 1857, ten years ago, it was only 52,000 hectares.

The price of raw sugar at the present time in France is from sixty-one to seventy francs per one hundred kilograms. To this must be added the duty, which, on beet-root sugar, is forty-two francs per one hundred kilograms, and on French colonial sugar thirty-seven and a half francs. After being refined this sugar sells for one hundred and twenty-five to one hundred francs per one hundred kilograms, which includes the duty.

The production of beet-root sugar in France is over two hundred million kilograms; about the same amount is imported. The consumption is two hundred and fifty million kilograms, and the difference is exported in the form of refined sugar to England, Switzerland, America, Algiers, and other countries.

It will be seen that France nearly supplies her own consumption of sugar, although (as has been before shown) that consumption has increased steadily every year.

GERMANY.

The development of this industry in Germany has been as remarkable as in France, and its progress has been marked with the same success.

While under the direction of the founder, Achard, who was assisted by government patronage, it was represented by two or three establishments, and subsisted until 1814. From that time till 1830 there was very little or no sugar manufactured in Germany. In 1830, measures were taken to establish this industry, for its development in France proved that the manufacture of sugar could be profitably carried on in Europe.

Since the establishment of the Zollverein this manufacture has been greatly extended, but within the last eight years, particularly, it has increased to such an extent as to completely drive foreign sugar from the market. The factories are unequally distributed among the different countries of the confederation. The greatest number is to be found in Prussia, and particularly in Silesia and Saxony, the soil of which is admirably adapted to the cultivation of the beet. The increase of the number of factories in Prussia is very marked. In 1840 there were only one hundred and two establishments; in 1865, two hundred and thirty-four.

In the Zollverein, as in France, the average amount of sugar produced by each factory has largely increased within the last twenty years, and the German manufacturers are enabled not only to work up more beets per day than formerly, but to extract a much larger percentage of sugar, the average being from five to eight per cent.

This large average yield of sugar, which is so much larger than it is in France, is one of the results of the different system of agriculture pursued in Germany, which system, in its turn, is due to the manner in which the tax on the production of sugar is collected. In France the duty is collected on the amount of sugar produced, and amounts to nearly forty-four francs per every hundred kilograms. In some instances, however, the duty is collected on the juice, with the understanding that if more sugar is produced than estimated it shall also be liable to the tax. In other words, the duty is collected on the manufactured article.

In the Zollverein a different system exists. The tax is levied on the beet before it is rasped, at the rate of 1.87 francs per each hundred kilograms of roots. When the yield of sugar is eight per cent. this amounts to a tax of 23.43 francs per every one hundred kilograms of the *manufactured article*. If the German manufacturer can extract more than

eight per cent. of sugar from the beet this increase is not taxed. With this system it is easily seen that it is the interest of the manufacturer to have only those beets produced which contain the greatest amount of sugar. It is the custom also to cut off from the root before it passes into the rasp all those parts, such as the neck, which contain the smallest amount of sugar, and in which the salts and nitrogenous matters are more abundant. Such a system as this does not tend to encourage the agriculture of the country. The manufacturers in many cases insist that certain manures shall not be used on the land at all, and the land is never manured previous to raising a crop of beets. The production per hectare is consequently very much less than it is in France, the average being only from 20,000 to 25,000 kilograms. Beets raised in this manner contain, it is true, much more sugar, but produce a smaller amount of waste pulp, which is used in other countries to so great an extent for fodder and manure. In the Zollverein the beet is cultivated for its sugar alone, the object being to produce the greatest amount of sugar by raising beets of the maximum sweetness. In France, on the other hand, the beet industry is thoroughly agricultural, and has for its object, not only the production of sugar, but also the improvement and fertilization of the soil; and upon the successful cultivation of this plant the agriculture of many districts depends.

The states of the Zollverein have quadrupled their production during the last fifteen years—180,000 tons of sugar having been produced in 1865–'66 against 52,586 tons in 1850.

The quantity of imported sugar has fallen during the same time from 52,568 tons to 12,562, showing that the foreign article has been nearly driven from the market.

In 1865–'66 there were thirty new establishments built and many old ones enlarged. The average yield of sugar is eight per cent.; of molasses, 2.40 per cent. This includes the returns from poorly managed factories, and those worked under the old processes. The sugar production of the Zollverein is at the present time 190,000,000 kilograms. Much of the sugar is obtained from the infusion of dried beet. The beets being sliced and dried and sent in this condition to the manufactory. As an illustration of the proportions which a manufactory may assume when conducted under this system we may cite the establishment at Waghäusel, near Carlsruhe, in the Duchy of Baden, in which 3,000 people are employed, a capital of 80,000,000 francs ($16,000,000) invested, and twelve acres of land covered with buildings.

The consumption of sugar in the Zollverein for the year 1867 was 160,000 tons.

AUSTRIA.

The beneficial results produced by the introduction of this new industry into Austria are shown by the fact that the amount of sugar consumed by each person has largely increased; that the manufacture sup-

plies entirely the home market; that large quantities of sugar are annually exported, while at the same time the tax on the beets used in this manufacture is the source of a large revenue to the state.

The following information in regard to the introduction and development of the manufacture of beet sugar in Austria was communicated to the Department of State by Mr. P. Sidney Post, United States consul at Vienna:[1]

"There is no industry of Austria which ought to interest the United States so much as the production of sugar from the beet root. The United States appears to be in every respect as well, and in many respects much better, adapted for its production than this country.

"Beets containing a large amount of saccharine matter can be abundantly and cheaply raised in all the northern States, and especially in the northwest; and if the great profit of converting them into sugar was fully understood, there would be plenty of capital for the supply of the necessary machinery.

"The machinery is expensive, and it requires a large amount of capital to commence operations, but it is doubtful whether there is any branch of industry which would so well repay capital and enterprise. The business cannot well be conducted on a small scale, and this disadvantage has, doubtless, hitherto prevented its being generally adopted in the United States. But when it shall have been given a fair trial, it must become a very important interest.

"The growth of the manufacture of sugar is as wonderful as the history of the legislation on this subject in Europe is interesting. The embargo of Napoleon which forced on France the production of sugar, proved to Austria how beneficial the industry would be to this empire; but the first factories were not built until 1830.

"In 1830 there were two factories; in 1851, 100; in 1861, 125; in 1862, 130; 1864, 136; in 1866, 140.

"There is a tax levied upon the beets before they are manufactured into sugar, and by this means the exact quantity consumed is known.

Quantity of beets converted into sugar during the years named.

	Cwt.
1851	5,411,770
1853	6,387,319
1855	7,989,390
1857	11,892,941
1858	15,681,114
1859	21,017,574
1860	18,511,909
1861	17,682,594
1862	17,112,066

[1] *Vide* Report on Commercial Relations, &c., for 1867, pp. 510.

	Cwt.
	21,080,121
	18,288,911
	24,197,127
	21,081,368

› decrease of 1862 and 1864 is explained by bad harvests; that of d 1866 was occasioned by the wars progressing in those years.
1866 the 140 sugar manufactories used—machines for cutting 223; cylinders for maceration, 44; juice centrifugals, 82; juice ,966; refining kettles, &c., 757; evaporation apparatus, 267; pans, odumene filters, 1,567.
ring the last sugar campaign there were consumed:

wt	10,664,614
cwt	64,235
wt	1,123
cords	6,041
nene for filtering, cwt	678,290

ring the campaign and part of the time during the rest of the ere were employed in the sugar manufactories 25,027 males and females. The daily wages of the laborers vary from twenty rs to one florin per day, and there were paid during the year over 00 florins on account of wages. While in 1851 but five per cent. ar was obtained from beets, in 1861, by the improvement in ery, the manufacturers were enabled to obtain six and a half per nd in 1866 they succeeded in obtaining seven and a half per cent. re sugar obtained from these beets equalled, in 1851, 27,058,850 ; in 1861, 115,059,636 pounds; in 1866, 158,109,887 pounds. At age value of thirty florins per centner, the amount realized from campaign equals 36,407,000 florins; or if we take the Austrian t its present value, and reduce the quantity to American meas-e sugar will be worth $9 75 in gold per hundred-weight, and the ield will be worth, in gold, $14,562,800.
government tax upon the beet is 40.9 kreutzers per centner of eets, and two florins (25½ kreutzer) per centner for dried ones. ernment tax on beet amounted—

	Florins.
	153,377
	5,659,202
	5,587,838
	6,989,838
	6,030,097
	7,926,202
	6,116,589

"By this increased manufacture the commercial proportions between the exports and imports of this article have been entirely changed, as is shown by the following tables:

*Imports and exports of sugar into and from Vienna in centners.**

Year.	IMPORTS.			Year.	EXPORTS.		
	Refined.	Powdered.	Molasses.		Refined.	Powdered.	Molasses.
1830	2,213	400,039	583	1830	267	7	....
1840	5,380	529,600	661	1833	18	....	....
1850	35,006	645,602	92	1858	30	8	....
1855	35,092	770,961	142	1860	10,757	1,359	....
1860	4,656	36,410	27,004	1861	155	1,890	....
1861	9,951	31,716	35,710	1862	....	587	....
1862	31,330	131,692	31,762	1863	....	736	....
1863	13,419	23,845	27,732	1864	47,673	39,245	....
1864	3,940	3,841	31,662	1865	110,212	363,144	....
1865	2,320	586	29,180	1866	153,631	34,056	....
1866	1,362	422	20,612				

* A centner nearly equals 123½ pounds.

"During the first six months of 1867 nearly 700,000 centners were exported. Thus it may be seen that thirty-six years ago all the sugar used in the empire was imported. Now the importation of sugar has ceased, and it has become an article of export and is no inconsiderable item in the balance of trade.

"The duty on the importation of sugar was reduced in 1855 and in 1862, and the interruption in the steady decrease of the import and increase of the export is owing to this cause.

"The heavy tax on the beet before conversion into sugar operates as a tax on the sugar. When sugar became an article of export there was a certain recompensation fixed, which in 1860 equalled five florins sixteen kreutzers per centner on refined sugar, and four florins twenty kreutzers on powdered sugar. In 1864 this recompensation was realized to six florins fifty-one kreutzers per centner on refined sugar, and to five florins thirty kreutzers per centner on powdered sugar.

"The continued import of molasses is explained by the fact that the molasses obtained from the beet is not fit for common use, but is used for producing spirits.

"Comparing the incomes from customs duty, and the tax on the production of sugar, we find not only that the proportion between the export and import has changed, but that there is a considerable increase in consumption at home. Giving the income in round numbers we have:

Revenues from the manufactures of beet-root sugar.

Year.	From customs duties on imports.	From internal revenue tax.
	Austrian flor's.	*Austrian flor's.*
1850	5,300,000	150,000
1852	5,900,000	500,000
1855	6,600,000	1,100,000
1858	3,600,000	4,100,000
1860	400,000	5,100,000
1861	400,000	5,800,000
1862	1,409,000	5,600,000
1863	800,000	7,000,000
1864	200,000	6,000,000
1865	100,000	7,900,000
1866	100,000	6,100,000

"Notwithstanding the diminished customs duty on sugar by the increase of the amount realized from the internal revenue sugar tax, the total result has grown larger, thereby showing that the domestic consumption must have been increased.

"The expense of the manufacture of sugar during the last year was—

	Austrian florins.
Cost of beets	3,414,000
Cost of manufactured sugar	2,582,000
Cost of manufactured molasses	72,700
Cost of spodumene	3,844,600
Cost of coal	2,601,100
Cost of wood	53,600
Cost of peat	10,800
Cost of coke	1,200
Cost of wages	3,500,000
Tax	6,116,600
Total expenses	22,196,600
Value of the sugar produced	36,407,000
For interest, profit, &c	14,210,400

"Thirty-nine and three-tenths per cent. of the entire income therefore remains for interest on the capital and profits of the business."

The following observations are extracted from a later and unpublished dispatch from Mr. Post, now in the archives of the State Department, and supplied for this report:

"The production and export of beet-root sugar is increasing, and the history of its increase is best shown by the following table:

Table showing the quantity of beets taxed and used during the last three years in Austria.

Season of—	No. of factories in operation.	Quantity of beets taxed.	Amount of tax collected.*	Average quantity of beets used by one factory in the three years.	Average amount of taxes paid by one factory during the three years.*	
		Vienna cwt.	*Florins.*	*Vienna cwt.*	*Fl.*	*Kr.*
1864–'65	143	18,040,561	7,387,609	125,916	51,600	[illegible]
1865–'66	138	15,612,209	6,393,199			
1866–'67	138	19,105,674	7,823,655			

* 40 95-100 kr. per Vienna centner.

Beet-root sugar manufactories in Austria and other countries, and their products.

Country.	Season.	No. of manufactories.	Quantity of beets taxed.	Quantity of raw sugar produced.	Quantity of sugar exported.
Austria	1864–'65	143	18,040,561 Vien. cwt.	*1,344,136 cust. cwt	
Do	1865–'66	138	15,612,209....do		506,074 cust. cwt.
Do	1866–'67	138	19,105,674....do		806,749....do.
Do	1868	166			
Zollverein	1864–'65		40,902,891 cust. cwt	3,413,214 cust. cwt	*373,985 cust. cwt.
Do	1865–'66		42,859,064....do	3,713,912 ....do	
Do	1866–'67		50,012,553....do	3,900,000....do	
Do	1868	300			
Belgium	1864–'65			437,896 cust. cwt	
Do	1865–'66			831,037....do	
Do	1866–'67			782,460....do	
Do	1867–'68	111		900,000....do	
Holland	1865			70,000 kilos	
Do	1867			5,790,000....do	
Do	1868	18			
Russia	1864–'65			3,326,141 poods	
Do	1865–'66			3,552,000....do	
Do	1866–'67			5,280,000....do	
Do	1868	293			

* Average for the three seasons 1864–'65, 1865–'66, and 1866–'67.

Production, consumption, export, and import of sugar in Austria from 1834–'35 to 1867.

For the season of—	Average quantity of beets taxed per year.*	Amount of raw sugar produced per year.*	Average import of colonial sugar per year.*	Sugar exported per year.*	Population.	Amount of sugar consumed per person.†	Average price of loaf sugar.‡	Number of factories in operation.
1834–1839	605,616	30,270	518,193	38	36,000,000	1.52	44.25	37.8
1839–1844	1,577,995	78,875	574,470	89	35,444,400	1.42	39.00	42.6
1844–1849	1,729,280	103,757	569,053	150	37,160,400	1.61	39.00	38.4
1849–1854	5,196,096	311,814	767,479	394	36,451,600	3.01	39.80	97.6
1854–1859	11,712,692	820,080	561,489	89	36,714,600	3.00	41.90	119.2
1859–1864	17,798,429	1,246,090	71,125	21,058	36,917,200	3.51	39.50	135.2
1864–1867	19,201,861	1,344,136	2,115	506,074	35,650,000	2.36	30.39	139.4

* Custom cwt. † Custom pound. ‡ Florins.

RUSSIA AND HOLLAND.

The present production of sugar in Russia, including Poland, is from one hundred and fifteen to one hundred and twenty millions of kilograms annually.

This country is destined to become one of the most important sugar-producing countries in Europe. The soil, which is a rich dark loam, produces excellent beets without manure, and is acknowledged to be the best for this purpose in Europe. The number of kilograms of beets per acre is generally very small, (twenty thousand,) but the richness of the beet is remarkable, nine and frequently ten per cent. of sugar being obtained. The number of factories in Russia at the present time is four hundred and forty, most of them, however, being of small size.

In Holland, into which the beet has been recently introduced, the cultivation and manufacture appear in the most flourishing condition. This is owing to the fertility of the soil, in which the beet grows to its full size, and retains at the same time its full saccharine properties.

The present production of sugar in Holland is about seventy-five thousand kilograms. The number of manufactories is ten.

UNITED STATES.

Attempts have been made at different times in this country to establish the manufacture of beet-root sugar, with, however, but moderate success. All of these attempts have, with but one exception, been on a small scale, while the industry was still in its infancy, and the prices of foreign sugar were much lower than they are now, or are likely to be again.

In 1838–'39 the "Northampton Beet-sugar Company," of Northampton, Massachusetts, made several hundred pounds of this sugar, and succeeded in raising beets of excellent quality and weight, but the enterprise did not prove financially successful. The most complete published account of this attempt is that given by Mr. David Lee Child.[1]

This enterprise is also referred to by Mr. E. B. Grant. Of the more recent endeavors he thus speaks:[2]

"In 1863–'64 the brothers Gennert of New York conceived the idea of manufacturing beet sugar. Mr. Thomas Gennert visited Europe for the purpose of studying the methods there employed. Upon his return the firm selected the prairie lands in the town of Chatsworth, Livingston County, Illinois, purchased twenty-three hundred acres, erected buildings, and commenced the cultivation of beets. In process of time they gathered their crop, which, owing to the drought, and also to the unfavorable method of planting, yielded only ten or twelve tons to the acre. The beets were of excellent saccharine properties, containing twelve and a half per cent. of sugar. The heavy outlay required exhausted their

[1] The culture of the beet, and manufacture of beet sugar, 1840.

[2] Beet-root sugar and cultivation of the beet, by E. B. Grant. Boston, 1867.

means; or, to use their own words: 'We started on too large a scale for our purse, which gave out too soon before the machinery required for successful working was finished; but experience has shown us sufficiently that sugar enough is contained in the beets, and that it can be got out. With our imperfect, or rather incomplete, machinery we extracted seven per cent. in melada. Those beets would average, with complete machinery, nine per cent.'

"The Messrs. Gennert have put their property into a stock company, called the 'Germania Sugar Company,' and have six hundred acres of land in cultivation with beets this season."

The following is their estimate of the profits of working one hundred tons of beets per day, according to the yield of sugar, and with a capital of $200,000:

At 6 per cent	73 per cent. profit.
At 7 per cent	91 per cent. profit.
At 8 per cent	109 per cent. profit.
At 9 per cent	127 per cent. profit.

In referring to this same enterprise, the Commissioner of Agriculture says as follows:[1]

"A promising beginning of beet-sugar making has been commenced at Chatsworth, Illinois, and fine samples of the sugar may be seen in the museum of this department. It has, of course, met with difficulties, surrounded by new circumstances, with high rates of labor, and interest on money, which will all, I have no doubt, be eventually overcome. Many individuals and companies stand ready to engage in the business when its success upon our soil is fully demonstrated. Then in the west, as in Europe, flourishing villages will spring up upon prairies that are now without population or improvements; and an impetus will be given to all other business by the successful manufacture of a raw product taken from adjacent fields, involving the supply of an imperative want of every class of our people."

The testimony of the best authorities on this subject, and the attempts themselves, prove that the beet may be grown successfully on our soil, and that when capital and enterprise are brought to the aid of this industry, success in sugar-making will be assured beyond doubt.

NEW PROCESSES AND MACHINERY.

Before giving a detailed account of the machinery and apparatus used in the manufacture of beet-root sugar, it has been thought advisable to briefly enumerate the processes, and report the machinery employed at the present time. This notice is condensed from an article by Mr. Basset, published in *Études sur l'Exposition*.

The manufacture of beet sugar, cane sugar, and any sugar extracted from a vegetable juice or sap containing saccharine matter, depends

[1] *Preliminary Report* of the Commissioner of Agriculture, for the year 1867, p. 10.

upon the following operations: 1st. The extraction of the sweet juice from the plant or part of the plant which contains it. 2d. This juice, which is never pure enough to produce good crystallizable sugar, by simple evaporation, must be purified. 3d. The juice must then be concentrated, in order to allow crystallization to take place. 4th. It must then be crystallized. 5th. The crystals must then be purified. 6th. The sugar must then be refined.

The following are the principal methods used in the manufacture of beet sugar at the present time.

The beet from which the juice is to be extracted must be first cut up. The beets are sometimes cooked previous to this operation, but the more common way is to use them raw. For this operation, cutters are used which cut the beets into ribbons or slices, or the root is submitted to the action of a rasp, and a pulp of the proper degree of fineness obtained. The last method is the one generally used.

The pulp is then submitted to pressure, an operation which is performed in various ways. The more common way is to put the pulp into sacks of a coarse woolen material, which are piled in layers upon a frame, each layer being separated by a plate of iron, perforated with holes, or by a grating of the same material, with narrow spaces between the bars. These sacks are then submitted to pressure, which is done by an ordinary screw press, or by a hydraulic press, or by both. The sacks, after being used, are washed and soaked in a weak solution of tannin.

The pressure, no matter how effectively performed, fails to extract more than seventy-five or eighty per cent. of the juice. As the beet contains ninety-eight per cent. of water, sugar, and soluble matter, and only two per cent. of residuum, there is a loss by this process of from eighteen to twenty per cent. of juice. To prevent this loss, the extraction of the juice by maceration, or the use of water instead of pressure, has been attempted. Various machines and processes have been used, generally with excellent success, but this method has not as yet superseded the more common method of pressure.

The name given to the process of purification of the juice is *defecation*. The object is to remove, as far as possible, the foreign matters remaining in the juice after pressure. These are principally nitrogenous matter, mineral substances, coloring matter, and the coagulable albumen. The coagulable albumen is removed by the action of heat, which causes it to become insoluble. To remove the other matters lime is added. These form, with the lime, insoluble compounds which are easily eliminated, but as an excess of lime combines with the sugar and forms saccharate of lime, which causes a loss of sugar by its becoming dissolved, and as this saccharate is injurious to the manufacture of good sugar, being one of the most active causes of discoloration in cooking, and its presence producing *sucre gras*, it is necessary to eliminate this excess of lime. This was formerly done by passing the juice through animal charcoal.

Mr. Basset[1] observes that he is ignorant what have been the motives which have induced manufacturers to make use of this operation, and remarks that the animal charcoal has no effect on the lime; that it does not act upon the saccharine alkalies; and that its decolorizing power—the only one it possesses—is of no value when the liquid is not free from the ulterior causes of the color, *i. e.*, the alkaline bases. The use of lime in large quantities for the purpose of eliminating the foreign matters contained in the juice has therefore been proposed. A solution of saccharate of lime is thereby obtained, which is cleared of the lime by passing a current of carbonic acid gas, obtained by the combustion of coal, through it. This is in principle the process which is known to-day under the name of *carbonation*. The carbonic acid acts upon the lime, but has no permanent effect upon the alkalies. It is true that the saccharate alkalies are decomposed by the carbonic acid, but as the alkaline carbonates are not removed, the saccharates are again brought together by the heat, and are an active cause of coloring and loss. M. Basset recommends the use of super-phosphate of lime in defecation, it being a cheap substitute and a more effective agent than carbonic acid, eliminating the lime, and at the same time destroying the effect of the alkaline salts which the juice contains. By some manufacturers sulphate of alumina is used to eliminate the lime. This, also, is an effective agent, and prevents coloring, but by its use deposits are left in the juice which are difficult to remove, and a sulphate of lime is produced, which must be removed by filtering at twenty-six or twenty-eight degrees Beaumé.

The different processes used in purifying the juice are briefly described by Basset as follows:[2]

ORDINARY PROCESS.

Elevation of the juice to the temperature of seventy-five or eighty degrees centigrade; introduction and mixture of milk of lime; elevation of the temperature to the boiling point; time to allow the liquid to settle; decantation of the clear juice; pressure of the foam and insoluble deposits: filtration of the juice through animal charcoal.

BARNUEL PROCESS.

This is the same as the above, with the following modifications: An excess of lime is introduced so as to turn the sugar into saccharate of lime. The liquid is then decanted and submitted to a current of carbonic acid. The juice is then allowed to settle and filtered as above described.

The sulphate of alumina process has been before referred to.

DOUBLE CARBONATION.

This is similar to Barnuel's process, with this exception, that after the first action of the carbonic acid a new quantity of lime is introduced, and

[1] Études sur l'Exposition de 1867, 3e Fascicule, 30 juin 1867.

[2] *Études sur l'Exposition de 1867.*

the juice is again subjected to the carbonic acid. Decantation and filtration the same as above described.

TROUBLED DEFECATION.

Elevation of the juice to the temperature of seventy-five or eighty degrees centigrade; introduction of lime; then, without decantation, the introduction of carbonic acid. Decantation, pressure of the deposits, and filtration of the juice through animal charcoal, as before described.

CONCENTRATION.

The purified, filtered, and decolorized juice is concentrated by the action of heat, which causes it to lose its excess of water, and brings it gradually to the density necessary for crystallization. This operation is divided into two parts: concentration, properly so called, and cooking or baking. It is well known that the boiling point of a liquid in a vacuum is at very much lower temperature than it is when exposed to atmospheric pressure. Upon this principle the application of the vacuum in concentrating and cooking the juice rests.

The introduction of vacuum boilers is almost the only improvement, in reality, which has been made in the manufacture of sugar for thirty years, for the elements of all the other improvements which have been made were contained in the old processes. With the apparatus now used, it is impossible to caramelize the sirup, and the cooking or baking may be pushed to crystallization—an operation which is called baking in grains, and which is described at length in the accompanying report; finally, the heat is not sufficient to cause the saccharate alkalies, which have been left in the juice, to produce any reaction of importance. The machines for concentration which have produced the best result are manufactured by MM. Cail & Co., and are known as machines of triple effect.

CRYSTALLIZATION.

This is usually done in vats. The sirup is exposed to a temperature of from thirty to thirty-five degrees centigrade, which is maintained as uniform as possible till the crystallization is complete.

The turbine, by means of which the sirup is separated from the crystallized sugar, is a great improvement over the ordinary and older methods. By the use of this machine the purification of the crystals of sugar is reduced to an almost instantaneous mechanical operation.

The other operations and processes connected with the manufacture of sugar, some of which are recent and some of older date, will be described at length in the accompanying report. At the present time the machinery for a complete and well-arranged sugar factory consists of washing machines, rasps, presses—mechanical and hydraulic, boilers of defecation, carbonic-acid boilers, carbonic-acid generators, foam

presses, animal charcoal filters, machines for concentrating and cooking the sugar, crystallizing vats, turbines and furnaces for revivifying the animal charcoal. To this must be added the engines and generators, the size and cost of which depend necessarily upon the extent of the factory.

Of the improvements which have been made of late years in the methods and processes of manufacturing sugar, M. Constant Say makes the following observations:

"Since 1857 the manufacture and refining of sugar has made great progress, the result of which is the production of sugar at a lower cost than formerly. The principal improvements in the manufacture are in the process of double carbonation, the apparatus of triple effect, of roasting *in vacuo*, and the use of centrifugal machines."

THE DIFFUSION PROCESS.

Mr. Post, consul of the United States at Vienna, Austria, writes as follows concerning the new diffusion process:

"The new process recently invented by Mr. Julius Robert, a sugar manufacturer of Seelowitz, Austria, is working a complete change in the manufactories here, and will doubtless exert a great influence on an extended introduction into the United States, and it is adapted to extracting the crystalline sugar from either sugar cane or beet root.

"Without entering into an extended description of this invention, I may say that the process differs radically from the old methods, their leading principle being to obtain the juice contained in the cane or beet root, and to this end they employed repeated grinding, or maceration, or powerful pressure.

"Mr. Roberts's 'diffusion process' does not aim at obtaining the juice contained in the cells of the cane or beet root, but to extract only the crystallizable sugar contained in that juice, and to leave whatever else it contains in the cells. To accomplish this purpose, the sugar cane or beet roots are cut into small slices and put into a number of vats, which are connected by pipes running from the bottom of one vat to the top of the next succeeding. Water of a certain temperature, and of a quantity proportioned to the weight of the cane or beet root in the vats, is mixed with the material in the first vat, and allowed to remain until it takes up a portion of the saccharine matter, or, so to speak, until the sugar in the vat is equalized between the water and the cane or beet root. That is to say, if the beet root contains eight per cent. of saccharine matter, the water will take up four per cent. This water is then forced by hydraulic pressure into the second vat, filled with beets.

"It already contains four per cent. of sugar; but the beets having eight per cent., it will again equalize itself, and when forced into the third vat will contain six per cent. of saccharine matter. In this way the water becomes more and more impregnated with saccharine matter, until it contains almost as much as the beet itself. To return to the

first vat, we find that the first application of water extracted one-half, or four per cent. of the sugar. When this water was forced into the second vat the fresh water which forced it out and supplied its place extracted two per cent. more before the saccharine matter became equalized between the water and the beets. This water is then forced into the second vat, and the fresh water which supplies its place finds the beets containing but two per cent. of saccharine matter, and the next filling finds but one per cent., and in this way the sugar is extracted to within one-half of one per cent.

"It is said that by this process the raw material is much purer than when extracted by any other method—that from the same beets one-half per cent. more crystalline sugar is obtained than by the application of pressure. The expenses for cloth, and the cleaning and renewing it, are entirely done away with; the expense for motive power and machinery is considerably reduced, and the expense of manual labor is much less, requiring but one-quarter of the number of laborers necessary for the pressing purpose.

"In the United States, where labor is so expensive, this innovation must prove of incalculable importance. The only thing required in this new process not necessary in the old is an additional supply of water, an article tolerably plenty and cheap wherever this manufacture is likely to be introduced in our country.

"That this process is really the great improvement claimed no longer admits of dispute. Mr. Roberts has thoroughly tested it in his factory, and has adopted it, as have also six other factories, two in Austria, two in Prussia, one in Russia, and one in Bavaria."

CHAPTER II.

CULTIVATION AND PRESERVATION OF THE BEET.

VARIETIES OF THE BEET—SOILS ADAPTED TO THE CULTIVATION OF THE BEET—METHODS OF CULTIVATION—MANURING—CULTIVATION IN DRILLS—CULTIVATION IN HILLS—SOWING—HOEING AND WEEDING—HILLING UP—HARVESTING—PRESERVATION OF THE BEET.

VARIETIES OF THE BEET.

The beet, which is a native of Turkey, is a half-hardy biennial plant. Its roots attain their full size during the first year. The seeds are produced from transplanted roots, after which the plant dies.

According to an analysis of the beet by Professor Payen, it contains—

	Per cent.
Water	83.5
Sugar in solution	10.5
Cellulose and pectose	.8
Albumen, caseine, and nitrogenous matters	1.5
Malic acid; pectine; gummy substances; fatty, aromatic and coloring matters; phosphate of lime; phosphate of magnesia; silicate, nitrate, sulphate, and oxalate of potash, &c	3.7
	100.0

Among the many varieties of the beet the following may be enumerated as best adapted for agricultural and manufacturing purposes: The long red mangel-wurzel, the German red mangel-wurzel, the long white green-top mangel-wurzel, the long white red-top mangel-wurzel, the yellow globe mangel-wurzel, the Imperial, the Magdeburg, and the White Sugar or White Silesian. The white or sweet turnip variety is the most desirable for general cultivation. Of this variety there are two kinds, viz: the white beet root with a rosy collar, which contains the largest amount of sugar; and the Silesian, a white beet root, with a green collar, containing less sugar. The roots of the Silesian variety grow almost entirely below the surface of the ground, and owing to their compact and firm texture, resist both frosts and spontaneous alterations better than any other variety.

Those who are not only distillers, but who are at the same time growers of the beet root, and who endeavor to obtain not only an abundant crop of saccharine matter, but also a large crop in weight of roots per acre, may advantageously raise beets which yield even less sugar than the Silesian variety, and which contain extraneous substances *prejudicial in the* manufacture of sugar, but not in the distillation of

alcohol. Among these varieties may be named the yellow beet of Germany, an oblong root with a yellow pulp, the beet with a pale yellow skin and white pulp, only slightly elongated—a variety which has been found in some countries nearly as rich in sugar as the sweet turnip. It is customary in Europe for sugar factories and distilleries to supply the growers with seed, at the same time contracting for the crop when grown. The French factories generally furnish the Silesian beet root seed.

To maintain the quality of the beet unimpaired it is necessary from time to time to renew the seeds, and select them with care. The simplest means which can be employed for this purpose is a salt bath, into which the beets are plunged, and their density ascertained. The sweetest beets sink to the bottom, and are preserved for seed. By careful selection in this way M. Villenorman has obtained plants which contain fourteen or fifteen per cent. of sugar. The richness in sugar is ordinarily in inverse ratio to the size of the beet, and in direct ratio to the density.

Grant considers the white Silesian variety to unite most of the desirable qualities for manufacturers. He says: "For the use of sugar manufacturers the kind of beet that can be cultivated with the most advantage is that which is richest in sugar and contains the smallest amount of alkaline salts. It is distinguished by the following characteristics:

"First. Its roots must have neither the form of a carrot, nor of a tuber, but be shaped more like a Bartlett pear. It must be long and slender, gradually tapering and free from large lateral roots.

"Second. It must not grow above the surface of the soil.

"Third. It must have a smooth white surface, and the flesh be white and hard.

"Fourth. Its size must not be too large, and its weight not exceeding five to eight pounds.

"The white Silesian beet, which is the one in general cultivation for manufacturers, unites most of these qualities; and of other kinds those are most preferred whose foliage is not upright, but broad, spreading, and lying upon the surface of the ground. The roots of beets possessing this peculiarity grow entirely beneath the surface."

SOILS ADAPTED TO THE CULTIVATION OF THE BEET.

The most productive soils are those composed of clay and sand, being at the same time somewhat calcareous, deep and easily ploughed. Sandy soils which contain clay and carbonate of lime also yield good crops, if they do not suffer from prolonged drought. On soils almost entirely argillaceous or calcareous the beet root attains but moderate size, and is liable to suffer from drought as well as from wet. Argillaceous soils, in order to be fitted for the cultivation of the beet, must be improved by draining. It is impossible to raise a good crop on gravelly soil, whatever may be its chemical constituents, inasmuch as the roots bifurcate and divide into several smaller roots, which are apt to retain

gravel and small stones which are afterwards very injurious to machinery when the roots are cut.

Grant, in his treatise before quoted, says: "Ground that is mell warm, and fertile, free from saline and alkaline constituents, not s and of a nature little liable to suffer from drought, easy to work lat autumn and early in spring, with a comparatively permeable sub penetrable by the tap-root of the beet, that affords natural drainag that it may be worked soon after rains, is suitable for the crop in q tion."

Count Chaptal, a great cultivator as well as a sugar manufactu says: "All grain fields are more or less suitable for beets, but especi those having a depth of twelve or fifteen inches of rich vegetable mo Fine, sandy alluvial bottom lands, overflowed in the winter or e spring, are favorable for the beet, and they need no artificial manure they are enriched by the inundations. Beets require to be planted thoroughly cultivated land in which the sods are entirely rotted."

The beet is generally cultivated in rotation with other crops, the s ground being successively sown with beets the first and second ye wheat the third, clover the fourth, and oats the fifth. When manur more sparingly used, a rotation of crops every four years is practic the yearly order being beets, wheat, clover, and oats.

METHODS OF CULTIVATION.

Beets are grown in two principal ways, in drills and in hills. latter method has of late years been much practiced in Europe, an attended with highly satisfactory results. In drill cultivation the D basle plough, drawn by ten oxen on heavy and by eight oxen on li soils, is used. The depth of the furrow is never less than twenty-ei or thirty centimeters, and frequently thirty or thirty-five when the is of such a character as to permit of it. A furrow of this depth all the root to strike deeply; and though the formation of the fur requires the exercise of considerable power, yet it brings to the surf in places where good soil is scarce the argillaceous subsoil, which coming in contact with the air is fertilized and improved by mixing w the vegetable soil and manure, the depth of the fertile ground at same time being increased.

Argillaceous soils are all twice ploughed before winter, and must ready before the heavy frosts. It has been noticed that after thaw these soils become very friable, and that part of a field which is ploug before the frost yields a crop far superior to that part of the same f ploughed in the spring. Light soils are ploughed in the spring, w manure can be more freely used, large quantities being produced dur factory work, which lasts from September 15 till January 31, dur which time the largest number of oxen are fattened. The same meth of tillage are employed on soils on which oats have been sown the y

before, and on which a crop of beets is to be grown, as on those which have grown one crop of beets and are to be again planted for a second crop.

MANURING.

As soon as harvest is over manure is hauled from the stables to the fields, at the rate from fifty to sixty cubic meters to the hectare, on soils on which oats have been grown, and which are to be planted with beets. On soils on which a second crop of beets is to be raised the same amount of manure should be used, although growers are often obliged to content themselves with less. Stiff and clayey soils are first manured and ploughed, and the ploughing should commence as soon as the manure is spread over the ground, the weather permitting, in order to have it perfectly mixed with the whole mass of earth.

CULTIVATION IN DRILLS.

When the ground is suitably prepared by ploughing, the sowing is done in drills about sixty-five or seventy-five centimeters apart, by means of a wheelbarrow drill or horse machine, which facilitates the subsequent operations of hoeing and digging. Hoeing is very important, for if the weeds are not torn out in time the tender beet will be soon overgrown and killed. Digging must be done also without delay, although the operation is seldom so urgent as that of hoeing. After hoeing, all the places where the seed has failed to take root are carefully replanted. For this purpose the plants thinned out from the places where the lines were too close are made use of. Another object of replanting is to preserve a regular distance of twenty-five to thirty centimeters between the plants, with the drills from sixty-five to seventy-five centimeters apart. From 46,000 to 53,000 plants, (without counting failures,) having an average weight of eight hundred grams each, can be grown per hectare, a total of from thirty-two to forty tons.

In average years the crop raised on good soils in the Aisne, Oise, and Ardennes departments, where there are a great number of sugar factories and distilleries, amounts to from thirty to forty tons per hectare.

CULTIVATION IN HILLS.

This system of cultivation is fast superseding the older methods, as much more abundant crops can in this way be produced, some growers succeeding in obtaining sixty tons of roots per hectare, where under the old system from thirty-five to forty tons only were raised. This method of cultivation requires much more care and labor than cultivation in drills, but the roots produced are much more dense and rich in sugar.

The soil is thrown either with a common or double plow into two

bands or furrows, one against the other; soil so prepared presents conditions more favorable for development of the roots in length and density, and at the same time diminishes the size of the collar, which portion of the beet contains the smallest amount of sugar. Plowing and manuring are done as in the other method of cultivation, with the exception that the manure is buried in the middle of the hills, where, from greater contact with the air, it more readily decomposes.

With heavy soils it will be found convenient to prepare the hills in the fall, so that the soil by contact with the air and winter frosts may be rendered more porous and friable. As the hills so prepared settle a little it will be necessary before planting to run the double plow between the furrows. Where fields are not manured until spring, the hills should be formed as early as March, the ground being first harrowed, then ploughed, then rolled with a heavy roller. The hills are made a second and even a third time, each of the operations being followed by rolling, so that all the hills may have an equal height, and that the summits of the hills in which the beet is to take root may be firm and not so liable to be dried up by the wind which prevails at that season of the year. During preparation of the hills from two hundred to five hundred kilograms of Peruvian guano is sprinkled over them, according to the quality of the soil.

The distance between the hills is important, as it affects in more than one way the growth and culture of the beet. The inclination of the sides of the hills being about forty-five degrees, the greater the distance between the hills the higher their summits will be, and the greater will be the length of the beet. The soil also with high hills is better drained, better permeated by the air, and easier influenced by the first heats, a circumstance which will facilitate early sowing and prolong the time of vegetation for the beet, increasing also the amount of sugar.

The distance between the hills contributes also to the facility of cultivation. The leaves readily develop in the space allowed them, and are at a sufficient distance from the ground so as not to be affected by the radiation of heat, which always destroys some of the leaves in flat cultivation.

The practice now is to make the hills fifteen centimeters high and eighty centimeters from the top of one to the top of the other. The hills are made flat on top in order that the beet in its first stages may develop freely and penetrate the whole depth of the soil. A thorough rolling always precedes sowing.

SOWING.

Sowing is done either by machines or by hand. In the first method an ordinary sowing machine is used, whose wheels have been exchanged for movable gorged rollers, which round off the edge of the hill, and are capable of being adjusted at the same time so as to correspond to the

irregularities in size of the different hills. Sowing by hand is, however, more easy, more economical, and insures a better crop.

In hand-sowing two or three seeds are planted in holes two or three centimeters deep and fifteen centimeters apart, when the hills are eighty centimeters from each other. They are covered with earth to the depth of two centimeters, which is afterwards lightly pressed to make the earth solid about them. The tool used in hand-sowing is a small fork with two prongs fifteen centimeters apart, corresponding to the distance of the holes from each other.

In machine-sowing from twelve to fifteen kilograms of seed is required per hectare, while hand-sowing requires only from six to ten kilograms of seed. There is also a marked economy in the amount of labor required in hoeing and digging, as the plants come up more regularly and are more uniform in size. The yield of roots by hill cultivation may be estimated as at least one-fifth greater than that obtained by cultivation in drills. A field of ordinary fertility cultivated and sown as above described and well manured will yield fifty tons of beets per hectare, and eighty tons per hectare may be raised if there are no failures, and if each root weighs one kilogram, there being 85,000 plants per hectare.

HOEING AND WEEDING.

About the first of April, when the roots have attained sufficient size, the first hoeing is done by hand; the earth is gently raised on both sides of the hill without touching the summit where the beet root is planted. This operation is done with a tool made for this purpose, the effect of it being to scratch the soil lightly, as if with a gardener's rake.

This tool is formed by two small harrows, about sixty or eighty centimeters long, connected together. These harrows are provided with teeth three or four centimeters long, and this tool is pushed backward and forward by a handle, with more or less force according to the nature of the soil.

The first weeding is done ten or fifteen days after this operation of harrowing, when the plants have acquired sufficient strength, and the first leaves are sufficiently developed. The workmen use a small and light hoe, and must be particular to destroy the weeds without injuring the young and tender plants. About the last of April and the beginning of May, the plants are weeded out. They are still small, but it is important not to delay the operation, because immediately after weeding they increase rapidly in size and strength, and are prepared to resist the injurious effects of heat and drought. If, on the contrary, the weeding should be delayed till the beets have become strong they would grow up with only two leaves, and their future growth would be retarded.

Only the strongest plants of each cluster are permitted to grow up. When the weeding has been once thoroughly done it will be seldom necessary to repeat it; the growth will be sufficiently active to cause

the leaves of the young plants to cover the summit of the hills. Toward the end of May the plants are hoed a second time, the ground on the sides of the hills and between them being loosened by a light plow from which the share and coulter have been removed. A plow is preferred to a cultivator, for the hill is cut by it on both of its declivities and the weeds are buried and made to rot in the middle of the small furrow. By this treatment the soil is also aired and fertilized, and the summit of the hill remains to be hoed by hand. A cultivator scratches up the soil without fully tearing up the weeds and necessitates a liberal use of the hoe to complete the work.

HILLING UP.

Toward the middle of June, when the beet roots have acquired a strong growth, earthing up or hilling is done. This is an important operation in which care must be exercised if a large crop is desired. It is of as much importance as deep plowing, without which a good harvest is impossible. The plow used to prepare the ground for hoeing is also used for this operation, but the coulter and share are not removed. At the time of sowing, the hills being made very flat, the roots strike into the earth to the entire depth of the loosened soil. In this second plowing the earth is thrown up above the collar of the beet root, and thus allows it to develop toward the summit of the hill, while at the same time it penetrates into the soil and acquires often a length of from forty to fifty centimeters. Care must be taken not to leave the collar of the beet uncovered, in which case it would contain far less saccharine matter than the rest of the root.

The Bodin heaper may be employed for hilling, but it has the disadvantage of not throwing the earth to a sufficient height above the collar of the beet.

HARVESTING.

Toward the 15th of September the beet crop is harvested. The beets are known to be ripe when the leaves become yellow and fall off. In spite of its length the root can be easily torn out by the hand by inclining it toward the side of the hill. The plow is also used for this purpose, the share and coulter having been first removed. It is directed into the middle of the hills under the roots which fall on either side partially covered by the earth, which protects them from the early frosts. The roots are now cleaned, the collar removed, and heaped together. Should a frost be apprehended the heaps are covered with leaves until they are collected in carts and placed in the pits.

The use of the plow in harvesting effects a notable saving in time and labor; nor is any of the labor lost, inasmuch as the plowing is useful for the succeeding crop, whether of wheat or beet root.

When two crops of beet roots are to be raised successively, every *movement of* the soil is beneficial, and it is not unusual to see the

second year's crop much better than the first. The soil which has been assiduously cultivated and exposed in hills for a year to atmospheric influences is well adapted to the growth of a second crop. The cost of cultivating the beet in hills is no greater than in drills, all things being considered; the plow takes the place of the hoe to a great extent, a larger surface of ground is exposed to the influence of the air, and the cultivation is deeper than that possible under any other system of cultivation.

PRESERVATION OF THE BEET.

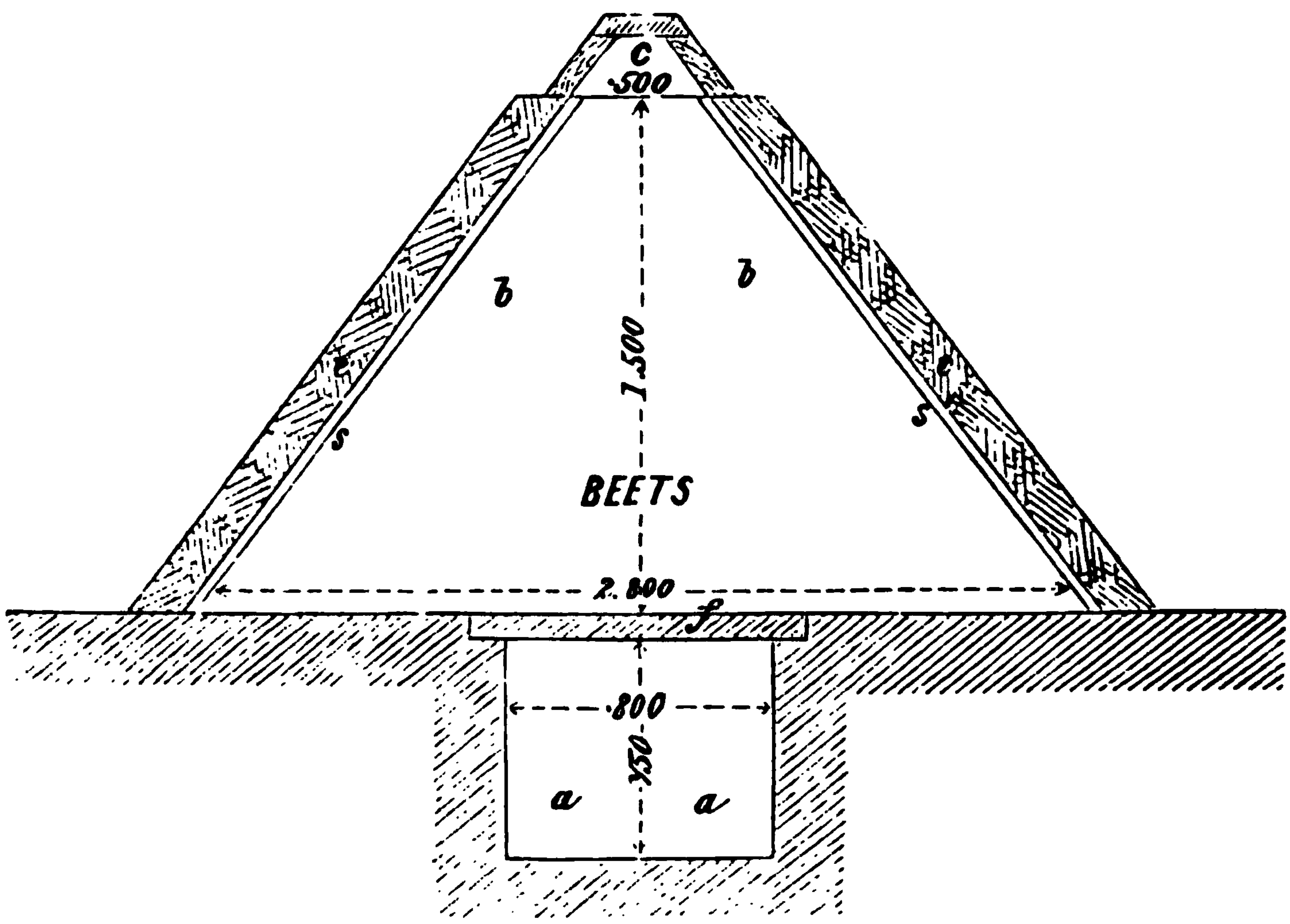
The proper conservation of the beet root plays an important part in the manufacture of sugar or alcohol. Many manufacturers lose large sums of money annually by the roots being attacked by the frost, which renders them useless for manufacture, or by their becoming blighted, which causes the root to sprout, and eventually deprives it of the best part of the sugar and renders the extraction of what remains extremely difficult. The beet should be so preserved as to be in exactly the same condition when worked up as it was when taken from the ground.

In France, and other countries, when the climate will permit, the roots are usually stored in heaps in the field or open air, and are protected by a covering of straw and earth, provision at the same time being made for drainage and ventilation. In making one of these places, or root-houses, (*silos*,) for the storage of the beet, a trench is first cut in the ground, over which the beets are afterwards placed in piles. The trench is made eighty centimeters wide and from sixty-five to seventy centimeters deep. The length varies according to the quantity of beets to be stored; it must be, however, at each end about one meter longer than the pile of beets. This trench is then covered with branches of trees or shrubs sufficiently thick to prevent the beet from falling through, but not too thick to prevent the air from freely circulating upward through the roots. In the middle of the pit a triangular chimney made roughly of pine boards three centimeters thick, twenty centimeters broad, and one and a half centimeter long, is set up. The beets are then piled up over this trench so as to form heaps with sloping sides about three meters wide at the base, and from twenty to twenty-five meters long, according to the length of the trench. No special care need be taken to make the piles regular in appearance, the beets roughly thrown together will naturally arrange themselves to the required shape. The height of the pile is usually about one meter and a half, corresponding to the height of the chimney. The upper part of the pile should be regular, so that the roof with which it is covered may fit evenly. The cover or roof is made of three pine boards so arranged as to fit the top of the pile. The sides are braced together at certain distances by grooved tie-pieces, the groove of which is .08 centimeters square. The width of the boards which form the gutter is from two hundred and twenty to two hundred and fifty millimeters. The length

is of less importance as the gutters or roofs can be placed one after the other according to the length of the pile. The most convenient length, however, is from three to four meters, which enables them to be handled with ease. At the end of the season they are stored away, and may be used till entirely worn out.

The annexed figure represents one of these root-houses or piles in cross-section.

Fig. 1.



"Silo," or Root-house, for the preservation of beets.

The trench is shown at the bottom *a a*; *f* the floor; *b b* the pile of roots; *s s* the straw; *e e* earth covering; *c* the roof. The chimney, which is merely a triangular tube of boards, is not shown.

As soon as the pits are ready they must be covered with straw and a layer of earth, from ten to twelve centimeters in depth. This may be done on any day, not rainy, whether warm or cold. The straw spread between the roots is quite necessary, for, being a non-conductor of heat, it prevents the roots from being injured by the heavy frosts, and supports the earth with which the pile is covered, leaving a free space between the beets themselves for the circulation of air. Near the chimney a triangular box about one meter long is placed, made of thin boards and extending into the pile. It opens at the top into the gutter or roof and is intended for the thermometer.

The preservation of the beet is divided into two operations: 1. Storing away the beet. 2. Superintendence of the pits.

The beets when stored must be well cleaned; that is to say, freed from the dirt attached to them, and the collar cut away, for any portion *of the leaves* remaining on the roots will become rotten in a few days and

produce fermentation in the pits. Care must also be taken not to put into the pits any roots damaged during loading the carts by the horses' feet or by the wheels. This rule is easy to observe as such damaged beets may be worked up immediately.

It is easy to see that the good preservation of beet roots depends upon their being kept cool yet free from frost, and dry and well ventilated. The root-houses are constructed in the manner described, in order to secure these essential conditions. A continuous current of air entering at each end of the trench passes upward through the floor of branches or brush, penetrates the pile of beets and finally passes out of the chimney at the top and at the ends of the roof or covering.

The temperature of the pit should never exceed three, four, or at the most five degrees above the freezing point.

The following are the methods adopted for maintaining the equable temperature.

Let us suppose that when the beet pits were made the weather was moderately warm, about eight degrees above the freezing point. The temperature in such a case should be lowered to three or four degrees. This is done by closing the ends of the canal and gutters with straw stoppers during the heat of the day, when the temperature is above eight degrees, and by opening them in the evening and during the night when the temperature has fallen below that point. By introducing the cool air in this way during the night and excluding the warm air during the day, in the course of a week the proper temperature will be obtained.

To maintain the temperature of the pits at this height, it will be only necessary to stop up the openings completely whenever the outside temperature is higher than four degrees, or lower than the freezing point.

That the differences of temperature may be ascertained a thermometer is introduced, which indicates the temperature of the air passing into the lower canal, while another is placed in the triangular box above referred to, which will indicate the temperature of the mass of roots.

The whole superintendence then consists in stopping and opening the gutters as occasion requires. In this way, with proper care, the beets can be preserved till the end of March, without sensible alteration.

The pits are usually from twenty to twenty-five meters in length. When placed in a line there is about three meters between them. When placed, however, in parallel lines, the canals are dug five meters from each other, in order that there may be between the pits room enough to take the earth intended to cover them. One thermometer will be sufficient for every five or ten pits. A pit twenty-five meters long and made as above described, will hold from forty to forty-five tons of beets; and if they are at the above-mentioned distances from each other, two million and a half of beets can be stored in pits on a single hectare.

Another method, which is more economical and generally used, consists in placing the beets in longitudinal heaps, about two meters wide at the base.

At harvesting, a thin layer of earth spread over the sides only is sufficient.

This allows the whole mass to become cool, and when the temperature of the air falls below the temperature of the beet, which is often the case in the fall of the year, the air permeating the interstices of the mass, and being necessarily at the same temperature as the beet itself, has a tendency to rise. The thin layer of earth covering the sides allows a sufficient circulation of air, which takes the place of the warm air escaping at the top. The proper temperature is thus obtained, which prevents the beets from being heated to such a degree as to cause their decomposition, which would take place were they entirely covered. The precaution of covering the beets with a thin layer of earth at harvesting is of great service, as it insures them against the hoar frost. As the season advances, to protect them from the heavier frosts, it will be necessary only to add more earth to the whole surface.

This method of conservation answers all purposes, provided proper care is taken. The great surface of the walls of the piles, and the large amount of earth to be heaped up, render this method, nevertheless, quite an expensive one.

Still another method has been devised, less expensive than the two preceding ones. The beets are placed in heaps from six to eight meters wide at the base, and from two to three meters in height, with gently sloping sides covered with earth. The heap, which extends as far as the supply of beets and the surface of the ground permits, is flat on top and covered with straw alone.

The only precaution to be taken is to admit the air to the heaps from below, so that it may freely penetrate the whole mass. In order to effect this, air drafts are established by digging channels in the earth, before storing the roots, to the depth and width of forty centimeters, running transversely to the heaps, and of sufficient length to extend beyond the pile when covered with earth, in order that the openings may be free. This being done, the piles are covered with earth on the sides, and with straw on the top, and the air channels left open from the outside. The circulation of the air will be free and in proportion to the difference between the temperature of the pile and that of the outside atmosphere, and by this means good ventilation will be effected. The only care required is to tend the air drafts, and not open them unless the temperature of the outside air is above the freezing point. For this purpose small heaps of dung are kept ready near each opening, with which they are to be stopped when the nights are too cold. In order to ascertain the temperature of the mass, so that it can, when desired, be maintained at a fixed point, there are set at different places in the mass channels made of small boards jointed together, so as to form an open-work frame, extending into the pile about half its height, in which a thermometer can be placed, which may be inspected from day *to day, in* order that the progress of cooling may be watched. It is

ıght that the temperature is sufficiently low at three or four degrees re the freezing point, at which time the cooling process is stopped the openings closed. The straw on the top of the heap will be suffit to protect the beets from ordinary frosts. Should heavy frosts be ehended, it will be well to cover the straw with a thin layer of fresh ure or earth.

here it is intended to preserve the beets for a long time, the first od of conservation should be adopted, as the results obtained are satisfactory, and as this method requires less attention.

hen the beets are to be worked up during the first month of fabriu, the second method will suffice.

ie third method is less costly than the first, but nearly an equal unt of care is required for the superintendence of the pits.

CHAPTER III.

PRODUCTION OF ALCOHOL FROM THE BEET.

CLEANING THE BEETS—BEET-WASHING TUB—ROOT-CUTTER—M. CHAMPENNOIS'S VERTICAL ROTARY DRUM ROOT-CUTTER—HORIZONTAL CENTRIFUGAL ROOT-CUTTER—MACERATION—MACERATION TUBS—CHAMPENNOIS'S PROCESS—JUICE COOLER—FERMENTATION VATS—CONTINUAL FERMENTATION—WINE CISTERNS—ENGINES, STEAM-GENERATORS, ETC.

In the production of alcohol from beet roots the principal operations consist in cleaning the roots, extracting the juice, fermentation, distillation, and rectification. M. Champennois's system is now generally adopted in France, as it requires less costly implements and the smallest amount of hand labor, producing alcohol in the most economical way. It possesses, also, the advantage of leaving a large amount of pulp, which is used for fattening cattle. The industry is also of such a character as to be carried on in connection with agricultural pursuits, and in every farm of importance a certain part of the year is devoted to this work. The method of extracting the juice by means of rasps and hydraulic presses, though employed to a great extent in sugar factories, requires costly machinery and much hand-labor. The juice, also, which is obtained by this process, is less transparent than that obtained by maceration in water or acetic vinegar. It contains in suspension albuminous and foreign matters, the presence of which seems to be largely due to the manner in which the juice is extracted. After the juice has been obtained, the remaining operations are similar to those in Mr. Champennois's process, which will be described hereafter.

CLEANING THE BEETS.

To obtain a speedy fermentation, and assist the process of maceration, the beets must be carefully washed and freed from all earthy matter adhering to them. Hoisting machines or elevators are made use of to raise the beets to the washing tub, which is usually placed at such a height that the beets, on being discharged from it, may fall directly into the funnel of the cutter. Though these machines are quite simple in construction, a description of the kinds most in use may not be amiss.

The first of these machines is inclined at an angle of from fifteen to twenty degrees to the vertical. It is composed of two drums, one at the top and another at the bottom, turning at the rate of from fifteen to eighteen revolutions per minute. The drums are made of cast iron or of wood, eighty centimeters in diameter and fifty centimeters in length. *A flat hempen* band fifteen centimeters wide connects the two drums,

and is furnished with buckets of sheet iron fifty centimeters long and twenty centimeters in width and depth, and placed from eighty centimeters to one meter apart. Women or children are employed to fill these buckets, by which the beets are lifted and discharged directly into the funnel of the washing tub.

Within a few years more economical hoisting machines have been constructed. They are inclined at an angle of from sixty to seventy degrees with the horizon. The drums and bands are similar to those in the machine above described. The band is furnished with wooden spattles the same width as the band which projects about fifteen centimeters, and are fifty centimeters apart. This band travels in a channel made of wood, placed between the two wooden pillars which support the gearing of the drums and rollers.

At the foot of this machine a hole is dug, into which the beets are thrown, and at the bottom a small hinged valve is placed, which is lifted by each spattle as it passes. The roots are thrown in this way over the spattles, which lift and discharge them into the funnel of the washing machine. The top drum is actuated by the engine; the bottom drum is supported in such a way that its position may be regulated by means of screws in order to tighten the elevator belt when necessary.

BEET-WASHING TUB.

The washing tub is a rectangular box, made of wood or sheet iron, one meter in height, and furnished with a revolving drum. The height of the box corresponds to the length of the drum, while its width is equal to the diameter of the drum, or from twenty to thirty centimeters wider. The bottom of the box is closed by means of an inverted pyramid, furnished with a discharge pipe, which carries off the dirty water as well as the earth and parasitic roots washed from the beets. The mud and refuse roots are collected, and afterwards used as manure. The drum of the washing tub is of sheet iron, five millimeters thick, perforated with holes fifteen centimeters in diameter, and from five to six centimeters apart from center to center. It is 2.50 meters long and .70 meter in diameter, and will wash from sixty to eighty tons of beets in twenty-four hours. A drum 1.10 meter in diameter, and three meters long, will wash two hundred tons of beets in twenty-four hours. It is fastened by three cross-bars to an iron shaft, which rests on two brackets attached to the side of the box. The drum is so placed that its axis does not exactly coincide with the axis of the box. This is done so as to leave sufficient room for moving the discharge plug, which is of cast iron, and is lifted either by a screw or by levers. The tub is filled with water to the depth of two-fifths of the radius of the drum, which is actuated by means of a pulley keyed to the shaft, and moves at the rate of fifteen revolutions per minute. A funnel underneath the head of the beet-elevator receives the roots, and introduces them into the drum at one of the ends. By the rotary movement the roots are rubbed in the

water, one against the other, thus detaching the earth adhering to them. They pass out through the other end of the drum, from which they are lifted by perforated sheet-iron screws, which drains them, and conducts them to the funnel of the root-cutter.

ROOT-CUTTERS.

As successful maceration depends largely upon the manner and regularity with which the beet root is cut, it is essential that this operation be carefully and well performed. If the slices are too thick they are not easily penetrated by the acetic vinegar, which is used in the process of maceration. On the other hand, when the slices are too thin they have not sufficient consistency, and will form into masses impenetrable to the acetic vinegar, the action of which will be confined to the outside parts of the mass, and leave the pulpy agglomerations untouched. The most convenient thickness for the slice is about one and a half millimeter.

The first root-cutters used had a revolving disk of cast iron from .60 meter to .80 meter in diameter pierced radially by four rectangular holes, furnished with grooved toothed blades, from .008 meter to .0010 meter wide, the width of the beet-root slices. These cutters, however, did not cut slices of a uniform thickness. The disk frequently became warped, which caused the knives to cut slices either of too great or too little thickness.

These root-cutters were afterwards abandoned for one having a vertical drum, invented by M. Champennois; and these, in turn, have been replaced by the centrifugal action root-cutter, invented by the same gentleman.

M. CHAMPENNOIS'S VERTICAL ROTARY DRUM ROOT-CUTTER.

This root-cutter, Plate I, is composed of a hollow part A, of cast iron, forming a fixed frame, and bolted by means of two rods to the supporting brick-work or timber. To this is attached the hopper through which the washed beets are introduced. To this frame a cast-iron piece B is fastened, and forms the socket or support for the vertical shaft. On the top of the frame A a horizontal shaft C, with a fast and loose head pulley, actuates the vertical shaft by means of a bevel gearing with a spring-wheel keyed to the end of the vertical shaft D, which carries the drum E, on which the blades are placed. This drum E, which is in the form of an inverted truncated cone, is 0.30 meter in height, 0.42 meter interior diameter at the upper base, and 0.22 meter at the lower. It is 0.010 meter in thickness, and is furnished with six rectangular grooves 0.24 meter long, into which the grooved toothed knives are fastened. A cast-iron stay F is fixed to the frame, leaving a working space of 0.010 meter between its edge and the inner wall of the drum E. The washed beets coming from the washing tub are conducted by a channel to the *hopper, and* thence to the drum E; at this place they are stopped by

the stay F, while at every revolution of the drum each blade cuts the roots into slices of one and a half millimeter in thickness. A light casing of sheet iron is placed around the cutting drum, forming an annular space through which the slices fall into the tank, where they are afterwards sprinkled with slightly acidulated juice. This casing is made movable so that the blades of the drum may be reached and removed as occasion requires. A machine, similar to the one above described, will cut one ton of beets in fifteen minutes, the velocity of the cutting drum E being from three hundred to three hundred and fifty revolutions per minute.

CENTRIFUGAL ROOT-CUTTER.

In the above described root-cutting machines the root remains immovable, the resistance which it offers to the action of the knives depending upon its weight and the shape of the hopper and machine.

In spite of the good results obtained by the vertical drum root-cutter, M. Champennois has modified it by making the blade stationary, and attaching them to the inner circumference of a drum. A centrifugal movement is given to the beets, forcing them against the knives by means of arms attached to a horizontal shaft, and moving in the interior of the drum. This root-cutter presents the following advantages: greater regularity in slices, less noise, less wear and tear of gearing, and it requires less motive power than the other system. This machine (Plate I, Figures 4, 5 and 6) is composed of a stationary drum A, in the form of a truncated cone 0.28 meter high, and 0.40 meter and 0.45 meter inner diameter at its respective bases, provided with six grooves 0.24 meter long, into which are fastened as many grooved toothed knives. To this drum is attached the feed hopper B, the inner diameter of which is 0.32 meter. A horizontal shaft C, to which is keyed the head pulley, carries at one of its ends a cast-iron disk D, armed with two flyers turning in the stationary drum, and leaving a working space of 0.010 meter between the edge of each and the inner wall of the drum. The beets come from the washing machine through a channel into the hopper B, and thence to the drum A. Here the flyers of the disk D drive them violently against the blades of the stationary drum, where they are cut into slices of a uniform thickness of one and a half millimeter, and from eight to ten millimeters wide. The stationary drum is surrounded by a thin casing E of sheet iron, the object of which is to direct the slices thrown out of the machine downwards. This casing is movable, so as to give access to the knives, and allow them to be taken out.

This machine can cut three tons of beet root in half an hour, with the shaft moving at the rate of three hundred to three hundred and fifty revolutions per minute. A single horse-power is all that is necessary to actuate it. Care must be taken that the blades be sharpened, that the edge has a proper inclination, and that the teeth and blades exactly correspond. The blades are fastened into the grooves by screw bolts,

and can be adjusted so as to vary the thickness of the slices; but care must be taken that they all cut equally.

The force, which is limited by the weight of the mass in motion in this machine, prevents serious accidents which hard bodies, such as stones, accidentally introduced with the beet are liable to produce. They may rub against the knives for several seconds without danger, but the ease with which the machine can be thrown out of gear by a single movement enables the workmen to prevent serious consequences. Another important advantage in this construction is that a pulp of uniform thickness is produced; the thickness, however, may be varied by inclining the knives more or less.

MACERATION.

One of the conditions indispensable to the success of maceration is that there should be no alteration in the beet after it has been sliced.

Before placing the slices in the maceration tubs they must be moistened with acidulated juice. For this purpose from twenty-five to thirty liters of weak juice are used for every ton of beet root, to which is also added one liter and a half or two liters of sulphuric acid, according to the season and the condition of the beet. A shallow wooden tank lined with lead is placed under the cutter and receives the slices as they fall. During the whole cutting operation the sliced beets in the tank are sprinkled with acidulated juice. The supply of acidulated juice is regulated in such a manner that it is exhausted only when the maceration tub is filled. When the sprinkling is carefully executed all spontaneous alterations of the pulp, which otherwise would take place by its contact with the air, are prevented.

After sprinkling, the pulp on coming from the tub will be of a white color. If any portions are dark-colored, it is a sign that the sprinkling has not been regularly or sufficiently done; and if this dark color pervades the whole mass, the sprinkling must be repeated. If the juice, as it runs to the fermentation tubs, has a brown color, the sprinkling has been insufficient and irregular.

The maceration tubs, described on page 45, are arranged in the arc of a circle, around the root-cutter as a center, so that each tub is at the same distance from the tank from which the slices are taken. The acidulated slices are thrown into these tubs and spread around the sides. This arrangement is intended to prevent the slices from being heaped up in the center of the tub—a disposition which would naturally take place if they were thrown carelessly in. This arrangement also allows the juice to drain towards the center of the tub.

Machinery may be, and in some places is, substituted for hand labor in filling the tubs.

The root-cutter is fixed at a height sufficient to place under it a wooden trough with a semi-cylindrical bottom, into one end of which the

slices from the root-cutter fall, and where the sprinkling with acidulated juice is done. This trough can be moved and placed successively over the tubs, the bottom of the trough being 0.50 meter above the top of the tub. The bottom of the trough is perforated with a hole 0.30 meter square directly over the center of the tub. This hole has a sliding door which can be opened when the tub is to be filled. Underneath this opening a cone of thin copper is hooked, 0.60 meter in height and one meter in diameter at its base, which distributes the slices around the circumference of the tub in the manner above described. A wooden or copper screw traverses the trough from one end to the other. This helix or screw is 0.40 meter in diameter with a broad thread 0.15 meter deep. It is actuated by a pulley keyed to one end, and turns at the rate of twenty-five revolutions per minute, and carries the slices from the end of the trough under the root-cutter to the other end, and delivers the sliced beets into the tubs.

A great economy of labor is effected by this arrangement, one boy being quite enough to superintend the filling of the tubs. The slices are also more easily sprinkled and a larger quantity of feeble juice can be used with the same amount of acid per ton of beets. As a general rule, two liters of sulphuric acid are mixed with one hundred and fifty liters of feeble juice to moisten one ton of sliced beet root. Where one and a half liter of sulphuric acid is used it is mixed with one hundred and twelve liters of juice.

To prevent the workmen's hands from being burned by handling the vessels containing the acid, a wooden tank lined with lead is placed above the root cutter, into which sixty liters of acid are emptied, which is sufficient to acidify 4,500 liters of feeble juice. A wooden float placed in the tank indicates, on a graduated scale, the amount of acidulated juice used in moistening the slices.

Another saving effected in filling the tubs by the aid of machinery is, that there is no loss of acidulated juice in transporting the beets from the cutter to the tubs.

MACERATION TUBS.

All distilleries must have three maceration tubs at least, the size of which varies according to the amount of work done. One tub should be in full operation while the second is beginning to work and the third is being filled or emptied.

The construction of maceration tubs is shown by Figure 7 on Plate I. The capacity of the tubs should not be more than three tons, and the height not over 2.500 meters. A tub of the capacity of three tons is 1.600 meter diameter at its interior base, or 1.70 meter at the top, and is filled to within 0.25 meter of the top. The best tubs are made of red fir or red-oak staves, 0.05 meter thick, hooped with iron. A double bottom of sheet-iron 0.006 meter thick, perforated by holes 0.007 meter in diameter, and 0.04 meter apart from center to center, is supported at

a distance of 0.08 meter from the bottom by an iron hoop running around the inside of the tub, and in the middle by angle irons, which prevent the sheet-iron plate from bending under the weight of the beet root.

The beet root is poured, as above described, into the tub, which, when full, is covered with a sheet iron cover 0.003 meter thick, perforated with holes 0.007 meter in diameter and .06 meter apart from center to center. This cover gives an equal distribution to the liquid, which flows over the whole surface of the mass. Above the double bottom the tub is provided with an emptying door of 0.40 meter square, through which, when the slices are thoroughly macerated, the pulp is removed. This door, which is of cast iron, swings on hinges, and is closed by means of an iron cross-bar, furnished with a screw, which presses on the center of the door. The juice, after percolating the whole mass of beet root contained in the tub, runs out through a cast-iron elbow pipe fastened to the bottom of the tub and provided with a three-way cock on a level with the middle of the tub. By turning this cock in one direction or the other the liquid is diverted either to the fermentation tubs or to the weak juice suction pump. To the upper part of the tub another three-way cock is attached, by turning which, either acetic vinegar or feeble juice can be delivered into the tubs.

The same feed and discharge pipes answer for all the tubs, the connection being made by cocks.

The first (placed near the top) supplies the weak juice; the second, the acetic vinegar; the third conveys the juice to the fermentation boilers; the fourth to the weak juice suction pump.

CHAMPENNOIS'S PROCESS.

M. Champennois's process consists in the use of acetic vinegar, or the residuum of distillation of the fermented beet root juice, called *wine*. The object of this operation is to extract from the beet the largest amount of sugar, restoring to it at the same time the nitrogenized organic substances, as well as the mucilaginous and saline matters taken from other slices by a preceding operation. In a word, the liquid residuum left by distillation is added to the compact residuum of washing by maceration, so that the compound contains all the elements of the beet root juice, with the exception of the sugar, which is converted into carbonic acid and alcohol.

The farmers obtain thereby a wet and hot residuum, which, when mixed with hay, can be used as fodder for cattle.

Formerly, shallow tubs were used; the whole amount of acetic vinegar was added at once, and the juice removed by the acetic vinegar directed to another tub; or, after traversing several layers of beets, it was directed, after it had obtained sufficient density, to the fermentation tubs.

The tubs now in use are of the size and construction before described. *The acetic vinegar* is distributed in thin streams to several tubs at the

same time: the flow is slower, the displacement of sugar in the cells is more regular and perfect than in the old method. The acetic vinegar being of less density than the natural juice of the beet, and at a higher temperature, has a tendency to remain in the upper part of the tub. It sinks gradually, however, to the bottom, and displaces in its descent the juice in the cells of the successive layers of beet.

The effect of working several tubs at the same time is to prevent sudden changes in the temperature of the juice being communicated to the fermentation tubs; for each tub being in a different stage of progress, one of them delivers hot and another cold juice at the same time, and these streams mixing together in a common pipe have the same temperature when they reach the fermentation tubs. This temperature should never be higher than twenty-five degrees centigrade, in order to prevent acid fermentation, by which the production of alcohol is materially decreased.

When a tub is filled with beet-root slices the upper cock is opened, by which a quantity of the weak juice of a preceding operation is admitted. The term weak juice is given to the acetic vinegar residue, which is only feebly charged with sugar, which remains in the tub after working. When the tub is filled with weak juice the cock is turned in the opposite direction, and the acetic vinegar direct from the distillation boiler is introduced. While the acetic vinegar runs into the tub, the beet juice is displaced and forced through the elbow pipe, which rises and passes through the three-way cock at the height of the middle of the tub, and through it into the fermentation tubs.

The amount of acetic vinegar to be poured into each maceration tub varies from one hundred and twenty-five to one hundred and fifty per cent. of the weight of the beet pulp, according to the amount of sugar contained in it, and the temperature of the fermentation, which varies from twenty-two to twenty-five degrees centigrade, according as the flow is more or less abundant.

The maceration is continued for six hours; the temperature as well as the density of the juice during that time being quite uniform. At the expiration of this time the temperature rises and the density of the juice is less; the flow of the acetic vinegar to the fermentation tubs is then stopped, and the cock is turned so as to connect the tub with the weak juice pump, and the juice contained in the tub is pumped to the weak juice tank, to be used in a succeeding operation. The emptying door is then opened, the pulp taken out, and the tub again filled. The time allowed for exhausting the weak juice, emptying the tub, and refilling it with fresh slices, is about two hours. Three complete operations can be conducted in twenty-four hours in each tub.

An interval of three hours is allowed in filling each tub. In this way the operation is carried on continuously. When the work is first commenced the maceration is started with boiling water instead of acetic vinegar—of which none is obtained until later in the process. Water is

heated in the distillation boiler to a temperature of ninety degrees centigrade, and is then run into the first tub, and the operation is continued until a sufficient quantity of acetic vinegar has been obtained.

When the beet root is rich in sugar, and has a firm, hard pulp, and the weather is warm, it is advantageous to let the juice flow from one tub to the other. In this case the whole amount of the acetic vinegar is directed to the tub farthest advanced in the process of maceration. The weak juice pump, which works continuously, raises the acetic vinegar, slightly impregnated with sugar, to the weak juice tank, from which it is directed to the other tubs at different stages of the operation. By this means the beet root can be lixiviated without too great an elevation of the temperature of the juice which flows to the fermentation tubs.

The first tub being exhausted is emptied, and the whole of the acetic vinegar is again directed to the tub in which the maceration is most advanced and nearly completed. The same order of operation is observed in the other tubs consecutively.

As a general rule, the work is continued day and night, in order that the flow may be maintained in the tubs, and to prevent any alteration or fermentation of their contents.

In small distilleries, with only three tubs, the process is continued for from twelve to fourteen hours only, in the following way:

The filling of the tubs is so arranged that the first tub is filled two hours before leaving off work. The second tub is exhausted, and the weak juice pumped from it into the weak juice tank, from which it is directed into the third tub, which is empty. The whole of the acetic vinegar from the boiler is then run into the second exhausted tub, and pumped from thence into the feeble juice tank. The juice contained in the weak juice tank is run into the first tub, recently filled, and the flow is regulated so as to continue throughout the night. The next morning when work is renewed, the night tub, which has been flowing during the night, will be found to be flowing hot, and the weak juice tank will be nearly empty. The second tub, which has stood empty during the night, is then filled with the sliced and sprinkled beets, and the juice in the third tub is pumped into the weak juice tank, from which it is run into the recently filled second tub.

When the distillation recommences, the acetic vinegar from the boiler is distributed simultaneously to the two tubs, one of which runs hot and the other cold, which gives the juice the average temperature proper for fermentation. The maceration is then continued in the manner above described.

COOLING THE ACETIC VINEGAR.

A more complete maceration has been obtained by using a smaller amount of cool acetic vinegar.

For this purpose, at the outlet of the distillation boiler a system of cocks is placed, by which a stream of acetic vinegar having a tempera-

ture of ninety degrees centigrade can be sent directly to the fermentation boilers, or to a cooler, where its temperature is lowered to from seventy to seventy-five degrees centigrade. For a factory working up four tons of beet root in twenty-four hours the cooler made use of is a tight vessel of sheet iron, 1.100 meter in diameter, and 1.500 meter in height. Into this tub a worm made of pipes 0.10 meter in diameter, and having a surface of five square meters, is placed. The acetic vinegar from the boiler passes into the top of the cooling tub, is cooled, and goes from thence to the maceration tubs. The wine to be distilled, when introduced into the distilling refrigerator, is about fifteen degrees centigrade; when it passes out the temperature is from thirty to thirty-five degrees centigrade. It flows thence to the lower part of the worm of the acetic vinegar-cooler, and thence to the wine-heater.

Thus by the contact of acetic vinegar in the cooler at ninety degrees centigrade, with the wine at thirty-five degrees centigrade, the temperature of the one is lowered while that of the other is raised. By thus raising the temperature of the juice passing to the distilling apparatus a saving of fuel is effected. The acetic vinegar-cooler is furnished with a discharge cock, by which the acetic vinegar may be run out when the worm is to be cleaned.

MIXING THE PULP WITH HAY OR STRAW.

The pulp which remains after maceration is usually mixed with hay or straw and fed to cattle.

The hay is first cut in the ordinary manner, and thrown into a pit, where it is mixed with the pulp from the maceration tubs, and the mixture is then thrown into boxes or vats.

The bottom of these boxes is made of brick-work, in order to retain the juice running from the mixture. From these boxes it is taken and fed to the cattle. The surplus is thrown into pits made of brick-work, where it can be preserved for six months.

By M. Champennois's process of maceration the weight of pulp is seventy or eighty per cent. of the weight of the beet. To this is added from ten to twelve per cent. of cut hay, and preserved in the manner above described.

COOLING THE JUICE, AND FERMENTATION.

In order to regulate the temperature of the juice there is generally placed between the maceration tubs and the fermentation vats an apparatus called the juice cooler. For a factory working up forty tons of beet root in twenty-four hours a cooler with a superficial surface of twenty-four meters is sufficient. This apparatus is a sheet-iron cylinder open at the top, into which is placed a series of tubes of thin copper of from 0.029 meter to 0.030 meter in diameter, and 1.500 meter long. To the upper tubular plate a cylinder is attached, into which the juice from

the maceration tubs runs. To the lower tubular plate a spherical or funnel-shaped cap is fastened, through which the juice passes into the fermentation vats. A stream of cold water introduced at the bottom of the cylinder circulates around the pipes, and rising passes out at the top. The temperature of the juice coming in contact with the cold water can be regulated so that the fermentation may be effected at a temperature of less than twenty-five degrees centigrade.

The vertical pipes attached to the maceration tubs which lead to the fermentation vats terminate at a funnel placed on a level with the top of the tub, when the juice, as it pours out, may be seen and its temperature ascertained. The funnels are soldered to a pipe conducting the juice either to the fermentation tubs or to the juice cooler.

FERMENTATION VATS.

The fermentation vats are constructed of red fir staves, and hooped with iron, similar to the maceration tubs. To the upper part of the vat a cock is attached, by which the vat is filled to a third of its height. Near the bottom another cock is attached, which serves to cut the liquid. To the bottom of these vats a valve, 0.10 meter in diameter is fastened, through which the contents of the vat can be discharged, into a brick cistern, as soon as the fermentation is completed.

A distillery which works up thirty-six tons of beet root in twenty-four hours requires six vats of twelve thousand liters capacity each, and a brick cistern of twenty-four thousand liters capacity. A vat of the above-mentioned capacity has an interior diameter of 2.30 meters at the top, 2.50 meters at the bottom, and is three meters in height. The vat is filled to within 0.20 meter of the top, so as to leave a space for the foam produced during fermentation.

In large distilleries the number of vats is increased. The capacity of each, however, is rarely greater than fifteen thousand liters.

The feed-cocks are supplied by a pipe common to all the vats, as are also the liquid-cutting cocks.

CONTINUAL FERMENTATION.

M. Champennois has invented an ingenious method by which a continual and steady fermentation is obtained. The principle is the application of a large mass of fermented matter constantly renewed to a smaller amount of saccharine and slightly acidulated juice. The action thus obtained on small quantities of juice destroys the germs of abnormal fermentation, and dispenses to a great extent with the chemical agents required in other methods of fermentation.

In this process a *tub bottom* is first prepared, which consists in diluting from fifteen to twenty kilograms of good beer yeast with from fifteen to twenty hectoliters of sweet juice at twenty-eight or twenty-nine degrees centigrade. The fermentation is then left to take place; after

which a stream of juice is let into the tub, which, coming in contact with the large mass of fermented matter, enters at once into fermentation. The flow of juice from the maceration tubs is continued until the fermentation vat is filled.

When the contents of the first vat are in full fermentation a second vat is set in operation by means of the fermented juice from the first vat. To effect this the *liquid cutting cock* of the first and second vats is opened and both vats are filled to the same level with the fermented juice. The juice from the maceration tub is then introduced into both of these vats. By the time both vats are filled the alcoholic fermentation in the first will be completed. Half of the contents of the second vat is then run into the third, and both are filled with juice from the maceration tub, and the process is continued in the same way with the rest of the vats.

In this way the fermentation can be conveniently regulated according to the temperature of the juice or the amount let into the vats. Should the supply of juice running into the two vats be too abundant, the contents of the vat in full fermentation must be divided between two or more tubs, and the juice directed to all of them at the same time. It must be born in mind that the *cutting* cock is to be opened only when the tub from which the fermented liquor is to be taken is in full fermentation. If the juice is not in this condition it will be better to produce fermentation by preparing a "tub-bottom" in the manner above described.

When the tubs are large, instead of "*cutting*" the amount of fermented matter contained in the tubs into equal parts, it will be better to run into the tub in which fermentation is to be produced only a small amount of fermented juice—enough to fill it to the depth of from 0.40 meter to 0.50 meter, and to introduce only a small quantity of fresh juice until the fermentation is well developed.

The surplus of the juice continues to flow into the principal tub which has served for cutting the liquid; this is thus more rapidly filled, and the contents more speedily fermented. By adding a small amount of beer yeast to the vat in which fermentation is to be produced, the operation will be hastened. The vats must be supplied regularly, and a uniform temperature of from twenty-two to twenty-nine degrees centigrade maintained. Care must be taken to prevent the temperature from becoming suddenly lowered, as the fermentation would be thereby considerably diminished.

When the fermentation is effected at twenty-five degrees centigrade the yeast will retain its activity for a long time, and the addition of fresh yeast may be dispensed with.

When the temperature rises as high as thirty degrees centigrade the fermentation is altered, and an acetic fermentation takes place; in this case fresh yeast must be added. The progress of fermentation may be easily marked by observing the thermometer immersed in the liquid, which during fermentation rises from twenty-two to twenty-five degrees,

and falls when the reaction is completed. The density of the liq decreases also as the alcohol is formed. By plunging into the liqu Beaumé's hydrometer the specific gravity may be ascertained, wh when the operation is completed, is one degree, the juice being five six degrees.

From twenty-eight to thirty-eight hours, according to the temperat is allowed for fermentation. It will be best to have the vats pla where a uniform temperature can be maintained.

It has been found that when the fermentation is carried on at a t perature of from eighteen to twenty degrees centigrade a larger amo of alcohol is obtained. At this temperature the fermentation goes slowly, but lasts longer and requires a large number of vats.

WINE CISTERN.

As soon as the fermentation in any of the vats is finished, the empty valve at the bottom is opened and the whole contents are dischar into the cistern of brick-work placed underneath, from which the ju is pumped and forced into the tank from which the distilling appara is fed. The advantage of this arrangement is that the vat can emptied in a few minutes, cleaned and refilled; while, should the ju be pumped directly from the vat, it would take several hours to em it; during this time the walls of the interior of the vat would bec impregnated with the yeast floating on the surface of the liquor, wh has a tendency to become sour when exposed to air.

Another advantage in this is that the wine for distillation is suppl in a purer condition than could otherwise be done, as the used-up ye and foam in decanting the juice from the vat to the cistern are lef the bottom of the vat, and the matters held in solution in the liquor h time to settle while it remains in the cistern.

CLEANSING THE VATS.

Every eighth day, at least, the cistern must be cleaned.

It is also necessary to observe the utmost care in regard to the cle liness of the fermentation vats. As soon as the vat is emptied it m be immediately washed with a brush and boiling acetic vinegar, wh cleanses the walls from all fermentable matters adhering thereto.

It must be then rinsed with fresh water, and afterwards with sligh acidulated water, in order to remove all traces of sour yeast. The aci lated water is used only in such quantities as will impregnate the wo The object being to prevent the alteration of the juice with which wood is soaked.

Care must be taken not to leave any juice in the bottom of the inasmuch as this, acting on a small quantity of wine, will cause a de in fermentation.

The scum from oil refineries is used to prevent the foam produced fermentation from being excessive.

ENGINES AND STEAM GENERATORS.

In small distilleries, where the still is heated directly by a furnace, ither horse-power or a portable engine is used.

In large distilleries the distilling and rectifying apparatus is heated y steam, in which case one or more steam generators are required. he motive power is usually a steam engine working at a pressure of m five to six atmospheres, by utilizing the steam from which a large ving in fuel is effected.

The main driving shaft, by means of belting, actuates—

First. The wine pump, which pumps the juice from the cistern under e fermentation vats to the feed tank of the distilling apparatus. The k to be performed by this pump is measured by the amount of tic vinegar delivered to the maceration tubs, which is usually one dred and fifty per cent. of the weight of beet root.

Second. The water pump, which must supply the same volume as the e pump. This pump forces the water into a tank placed by the side the wine tank, which supplies the water required for condensation in rectifying process, and for washing the beet root and the utensils d in the distillery.

Third. The weak-juice pump, which exhausts the juice from the aceration tubs and forces it into the weak-juice tank. This pump has e same power as the two preceding ones. It is used only when the ice is to be pumped from the tubs—an operation which lasts from irty to forty-five minutes. As the weak-juices flow hot, the pistons d valves of this pump must be covered with leather which will not be injured by the heat.

The escape steam from the engines, which is utilized for heating the istilling vessel, is collected in a large cylindrical sheet-iron reservoir, the upper part of which is furnished with a safety-valve regulated for a slight pressure, so that there will not be too great a resistance or ack-pressure on the engine. Through this valve all the steam escapes which has not been absorbed and condensed. The water produced by condensation in this reservoir flows out through a pipe to another sheet-iron reservoir called the condensed-water reservoir. Into this reservoir the water, heated by the condensing worms, also flows and accumulates, and is pumped from time to time by the feed pump. Cold water can be introduced if required. By thus using the steam for heating the distillation boiler, and by feeding the boiler with distilled water at from ighty to ninety degrees centigrade, a great economy in fuel is effected.

For heating the distillation boiler, steam from the generators alone is sed, as it is essential that the pressure should be uniform so that no ariation in the flow of alcohol be produced, which would be prejudicial to its quality.

DISTILLATION.

CONTINUAL DISTILLATION.

This apparatus is composed of, first, the boiler; second, the distillation column; third, the condenser or wine heater; fourth, the refrigerator. The acetic vinegar refrigerator before mentioned may also be included as a part of this apparatus. The dimensions of the heating and cooling surface for each part of the apparatus is determined by the amount of fermented juice or wine to be distilled in twenty-four hours. In small distilleries, where the heating is effected with an open fire, the cylindrical boiler, or, what is preferable, the Cornish boiler is used. This is made of sheet iron, from six to eight millimeters thick, and is similar to the boilers formerly used with low-pressure engines.

DISTILLATION BOILER.

This boiler is a sheet or cast-iron cylinder. Sheet-iron boilers, however, wear out in seven or eight years. Inside of this cylinder, a worm made of copper is placed, in which the steam from the generator circulates. A cock, placed at a convenient height, serves to regulate the amount of steam let into the upper part of the spiral worm. The steam flowing through this worm is condensed and the water formed passes out at the bottom into the condensed water reservoir.

The boiler is provided with a water indicator; with cocks to discharge the acetic vinegar either to the maceration tubs or to the acetic vinegar cooler; with a supply-cock, by which water to be heated either for maceration or for washing the boiler is introduced; with a discharge-cock; with a manometer; with a water column; and with a man-hole, by which access is had to the interior for the purpose of cleaning the tubes.

DISTILLATION COLUMN.

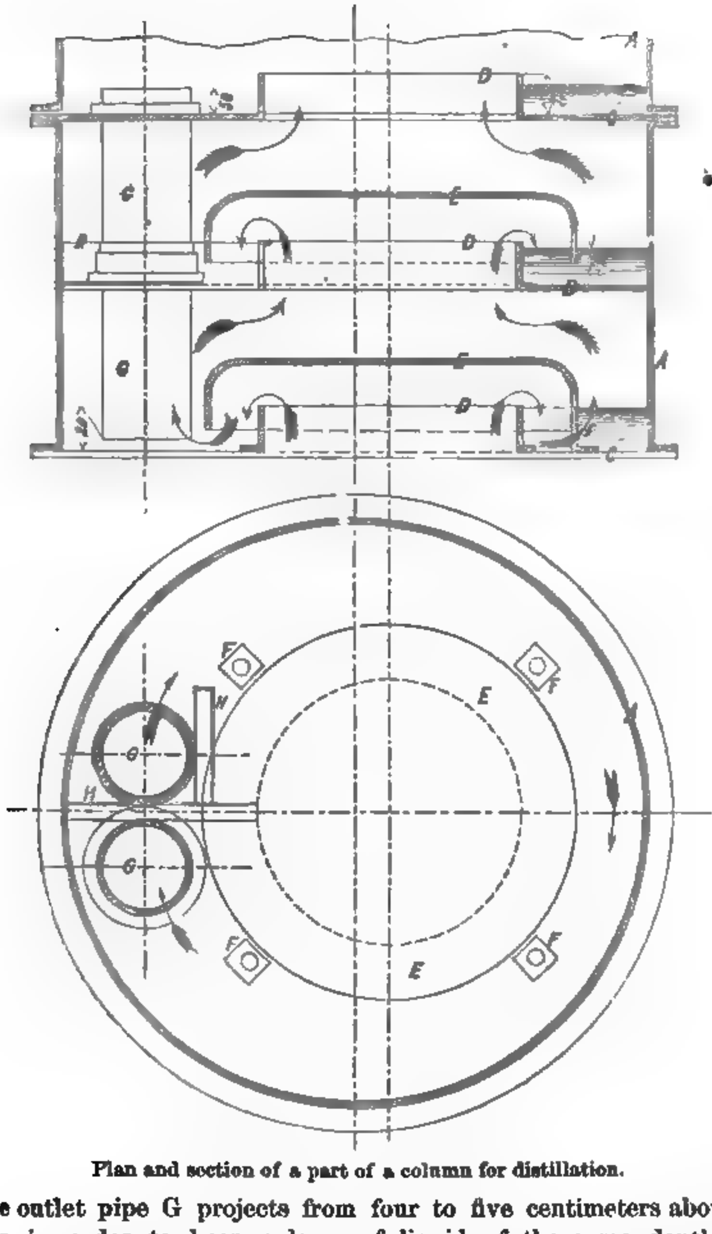
This is placed over the cover of the boiler, and is composed of ten shallow cylindrical copper trays or vessels shown in plan and section by the annexed figures.

The diameter and height of each one of these vessels varies according to the power of the apparatus.

In the middle of each, a plate B, forming a diaphragm, is welded, and between the joints of every two vessels a plate C is fastened. Each one of these plates is three millimeters thick, and is provided with a pipe or opening D near the center, through which the steam rises from the boiler. This opening is covered with a bell-shaped plate E E, supported at four points F, at such a height that its edge descends below the surface of the liquid which stands in each vessel. It is provided with an outlet pipe G for the discharge of the liquid. An inclosure or wall

H forces the liquid which runs down from one plate to the other, to circulate around the bell E before flowing to the plate next below.

Figs. 2 and 3.



Plan and section of a part of a column for distillation.

The outlet pipe G projects from four to five centimeters above the plates, in order to keep a layer of liquid of the same depth over each of them. Its length is such that the lower end reaches to within fifteen or twenty centimeters of the lower plate, so that it is plunged in the liquid retained on this plate, and prevents the alcoholic vapors

which are disengaged from the boiler from passing back. The escape-steam pipe D projects twenty centimeters higher above the plate than the discharge pipe. By this arrangement the liquid retained on each of the plates cannot flow down through the pipe D, which permits the alcoholic vapors only to pass.

The bell E, which surmounts the pipe D, is fastened by four cramps F, and supported at such distance from the plate that the lower end is plunged only twelve or fifteen millimeters in the layer of liquid retained on this plate.

The operation is as follows: The alcoholic vapor escaping from the boiler passes through the openings D, while the bells E E force it to come in contact and traverse a layer of liquid of from fifteen to twenty millimeters in depth on each of the plates, while at the same time the wine coming from the top of the column runs from plate to plate through the discharge pipe G, and thence to the boiler.

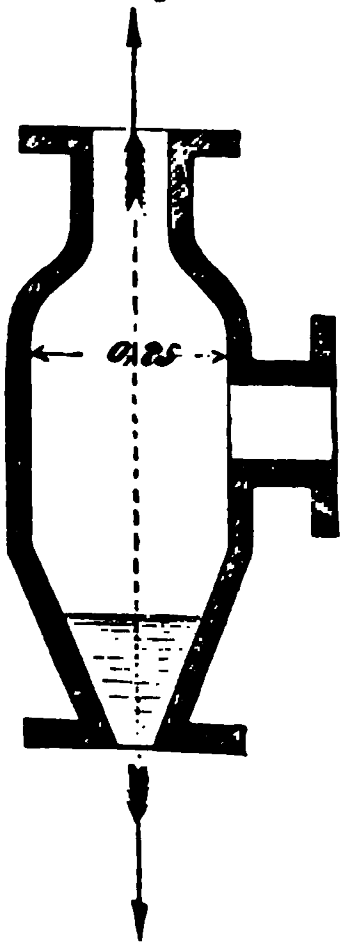
The lowest plate, which is directly over the boiler cover, is provided with a discharge pipe, the length of which is such that it extends to within 0.20 meter of the bottom of the boiler. The joints of the column are made tight by a luting or packing of pasteboard, and a putty or mastic of rye flour. They are drawn close together by means of iron pins or clamps four centimeters wide, placed around the edges of the flanges of the vessels, at distances of from three to four centimeters from each other.

Care must be taken when the column is set up, that the plates be laid exactly horizontal. This arrangement of the column in sections permits the whole of its interior to be readily cleaned when it is taken down.

The top of the column is closed by a cover furnished with a pipe which carries the alcoholic vapors to the wine heater.

WINE-HEATER.

Fig. 4.



Analyzer.

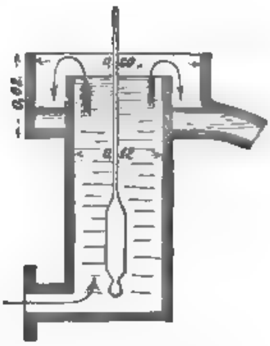
The wine-heater is a sheet-iron cylinder, in which an agitator is placed which prevents the matters suspended in the wine from settling. It contains, also, a copper worm, through which the alcoholic vapors pass, and make their exit at the lower part, which is furnished with an analyzer of thin copper. While passing through this worm, the aqueous and alcoholic vapors are condensed, and form what are called *small waters*, which issue from the lower part of the worm, with such portions of the alcoholic vapor as has not been condensed and flow to the analyzer, shown in section in the accompanying figure. The small waters sink to the bottom of this vessel, and are carried through a return pipe to the top plate of the distillation column, while the alcoholic vapor passes from the upper part of the analyzer to the worm of the cooler. A partition of the aqueous and alcoholic vapors is thus partially effected.

CONDENSER.

The condenser is a cylindrical sheet-iron vessel, in which a copper worm, formed of pipes of larger diameter at the top than at the bottom, is placed. The alcoholic vapors from the analyzer enter this condensing worm at the top, and are completely condensed and issue at the lower end, passing thence to the measuring gauge. The condenser, as well as the wine-heater, can be readily emptied by means of a discharge-cock placed at the bottom.

MEASURING GAUGE.

Fig. 5.



Measuring Gauge and Alcohometer.

The measuring gauge, represented in the accompanying figure, is a small copper cylinder, twelve centimeters in diameter and 0.29 meter in height, in which both a thermometer and alcohometer are plunged, in order to ascertain the temperature as well as the specific gravity of the alcohol. Its temperature, as it issues from the condenser, should be between sixty and seventy degrees centigrade. It is called at this state "phlegms."

The "phlegms" enter at the lower part of the gauge, and make their exit at the upper part to a small tank, from which a pipe leads to the reservoir where the alcohol is kept before rectification.

MANAGEMENT OF THE DISTILLING APPARATUS.

In the distilling apparatus only such wine is used as contains not more than five or six per cent. of alcohol, and which is sufficiently fluid to permit the alcoholic vapors to pass and be condensed. The wine is heated during this operation, and on arriving at the boiler it is nearly at the boiling point, one hundred degrees centigrade. The apparatus is so constructed that the alcoholic vapor passes from the boiler in a direction opposite to that taken by the wine used for condensation and cooling. The wine is pumped from a cistern, placed under the fermentation vats, and forced into a reservoir placed above the distilling apparatus. This reservoir contains a float to indicate the level of the liquid. From this reservoir the wine is conducted by a pipe to the supply-cock of the distilling apparatus. This cock is placed within reach of the workman, near the measuring gauge and steam supply-cock, which communicates with the worm and boiler.

The quantity of wine introduced into the apparatus is regulated by this supply-cock, and the careful regulation of this supply and of the supply of steam is the most important part of the management of the apparatus. The more energetic the heating the more vigorous will be the flow in the

measuring gauge, and the "phlegms" will measure less on the alcohometer. On the other hand, if the wine is supplied abundantly, the flow in the measuring gauge will be less, while the "phlegms" will mark more on the alcohometer. That these effects should be in correlation with each other is easily explained. In the first instance, the abundance of alcoholic vapor overcomes the condensation effected by the steam; in the second instance, the condensation is more vigorous, owing to the increased supply of wine.

The manometer attached to the boiler should indicate a pressure of from one meter to 1.20 meter of a water column. The distiller must be guided by the manometer and the measuring gauge in the management of the apparatus. When the heating is too active, the manometer rises, and the flow in the measuring gauge increases; when the heating slackens, the manometer falls, and the flow decreases. The distiller must, therefore, regulate the cocks, first, so as to obtain a distillate of the required strength; second, so that the acetic vinegar or residual liquor in the still shall be deprived of its alcohol, after having remained there a sufficiently long time, and that on passing to the maceration tubs it may be of a specific gravity of one degree Beaumé.

When the acetic vinegar, on issuing from the boiler, still contains a portion of alcohol, the supply-cock must be partly closed, so as to slacken the flow, and cause the acetic vinegar to remain longer in the apparatus.

In order to ascertain the presence of alcohol in the acetic vinegar, a cock of fifteen or twenty millimeters diameter is placed near the top of the boiler, through which a part of the steam formed in the boiler is withdrawn, condensed, and tested with an alcohometer. If the instrument stands at zero it is certain that the acetic vinegar has been exhausted of its alcohol.

CONCLUSION.

The wine at the temperature of fifteen degrees centigrade is introduced into the lower part of the condensing vessel surrounding the worm, and when it is discharged its temperature is between thirty-five and forty degrees centigrade. A series of cocks is arranged near the discharge pipe of the condenser, by which the wine is caused to flow to the worm of the acetic vinegar cooler, where it is heated to between sixty and seventy degrees centigrade. It then passes to the wine-heating cylinder and is further heated to eighty degrees centigrade.

When the acetic vinegar cooler is not used, or when it is being cleaned the wine passes directly from the cooler to the wine heater. From the wine heater the wine is carried by a pipe to the fourth upper plate of the distilling column, and thence, running downward from plate to plate, is finally discharged into the boiler.

When the work commences the supply-cock is opened, and all parts of the apparatus are filled with wine. The boiler is also filled, so as to entirely cover the heating or steam coil. The supply-cock is then closed

and steam introduced into the coil of the boiler. The evaporation commences, and is continued until the "phlegms" commence to flow to the measuring gauge, when the feed-cock is opened, and the supply is regulated so as to maintain a continual flow in the measuring gauge.

As the boiling point of water is one hundred degrees centigrade, and that of alcohol seventy-eight degrees centigrade, the vapor rising from the boiler, which is a mixture of aqueous and alcoholic vapors, on passing over the liquid contained on the plates of the distillation column, which is at a temperature which will condense water, causes the aqueous portion alone to be condensed, while the alcoholic vapor passes on, and, while traversing the wine covering the plates, takes up a part of the alcohol contained in it. The wine, when introduced at the top of the distillation column, contains the largest amount of alcohol, and is at the lowest temperature. As it falls successively from plate to plate, it becomes gradually heated, and loses its alcohol by evaporation, so that on arriving at the last plate it is entirely deprived of alcohol, while its temperature is nearly one hundred degrees centigrade. The "small waters" flow back from the analyzer to the first plate of the distillation column, and thence fall to the fourth plate, where they mix with the wine.

After passing over the plates covered with wine the richness of the vapor is further increased by traversing the last three plates covered with "small waters," which are a mixture of water and alcohol, richer than the "wine."

The vapor from the column then passes to the worm of the wine-heater, which is plunged in wine of such a temperature as will cause the aqueous vapor mixed with the alcohol to condense. The "small waters" produced by this condensation flow back through the analyzer to the column, as above described.

The alcoholic vapor issuing from the analyzer, taking with it a certain portion of steam, flows to the worm of the condenser, or "refrigerator," where it is completely condensed by the wine which surrounds the worm, and is at a temperature of fifteen degrees centigrade when it enters. The "phlegms" produced by this condensation pass to the measuring gauge, and should indicate from sixty to seventy degrees centigrade. As these "phlegms" contain a part of the essential oils of the beet, they require rectification.

CHAPTER IV.

PRODUCTION OF BEET SUGAR.

ENGINES AND BOILERS FOR A SUGAR FACTORY—EXTRACTION OF BEET JUICE—WASHING THE BEET—RASPING MACHINES—PRESSING—SHOVELING MACHINE—HYDRAULIC PRESS—INJECTION PUMPS—JUICE REFINING—DEFECATION—DOUBLE CARBONATION—CARBONATION BOILERS—WASHING—FILTRATION—EVAPORATION—BOILERS FOR REHEATING THE SIRUP—CRYSTALLIZATION—BAKING IN GRAINS—PURIFYING THE SUGAR WITH TURBINES—THE FIRST, SECOND, AND THIRD RUNS OF SUGAR—SCUM PRESS—PURIFYING AND DECOLORIZING—LIME FURNACE—GAS WASHER—PREPARATION OF LIME-WATER—WASHING AND VIVIFICATION OF ANIMAL CHARCOAL—ANIMAL CHARCOAL VIVIFYING FURNACE—GAS-LIGHTING APPARATUS.

The fabrication of beet sugar consists of five distinct operations:

First. The extraction of the juice, comprising the washing, cutting and pressing.

Second. The elimination, as far as possible, of the foreign matters accompanying the sugar, which comprises defecation, carbonation, filtering, and pressing the scum.

Third. The ulterior concentration of the juice in the best conditions for preserving the sugar, and for economy in combustion, including evaporation of the juices and the concentration of sirups, or baking.

Fifth. The separation of the sugar from the molasses.

To these operations may be added two others, viz: The revivification of the animal charcoal, and the manufacture of lime and lime-white.

Before describing these operations a few words may not be amiss on the steam generators, transmission belts, pumps, elevators, &c., indispensable for every sugar factory.

ENGINES AND BOILERS FOR A SUGAR FACTORY.

Every sugar factory should be furnished with several steam generators, (the number varying according to the size of the factory,) to produce the steam required for the engines and for heating the other apparatus.

Their heating surface is determined by the amount of steam which they produce per square meter, according to the system adopted. The boilers are connected together by means of steam or feed pipes. It is usual to have a spare generator, which can be used in case of an accident happening to any one of them, or when it is necessary to clean them.

Tubular generators have, of late, been more generally used, as they are most economical. They are fed with distilled water at a temperature of from eighty to ninety degrees centigrade from the different boilers

and other apparatus. They require cleaning only at long intervals, and will produce from nine to ten kilograms of steam for every kilogram of pit coal of good quality used.

Instead of a single steam-engine setting in motion all the machinery by means of belting, it is preferable to have an engine for each separate apparatus or sets of apparatus. It is evident that with a single engine, should an accident happen to it, the work throughout the whole factory would be stopped.

A separate engine is used for the following operations:

First. To set in motion the rasping apparatus.

Second. To give direct motion to a cylinder exhausting the carbonic acid gas from the limekiln, and forcing it into the carbonizing boilers.

Third. To work the air-pump which produces the vacuum in the evaporating apparatus.

Fourth. To work an air-pump which produces the vacuum in the baking boilers. (There are as many engines as there are baking boilers.)

Fifth. To set in motion the turbines.

Sixth. To pump the water required for the evaporating and baking apparatus, and for washing the beets.

Seventh. To work the generator feed pump. This engine is placed near the steam-generators, so as to be tended by the same workmen.

All these engines work under a pressure of from five to six atmospheres.

The steam from the engines, instead of being allowed to escape, is collected in a large reservoir and utilized for heating the evaporating apparatus, by which a large economy in fuel is effected.

This reservoir, which has been referred to in describing the process of distillation, is known as the exhaust-steam reservoir, and is composed of a vertical or horizontal sheet-iron cylinder, one meter in diameter and from two meters to 2.50 meters in length. The escape pipes of all the engines lead to this reservoir, which is provided with a safety-valve arranged for a pressure of one and a half atmosphere. The water condensed here passes out through a pipe to the condensed-water reservoir.

The condensed-water reservoir is a sheet-iron cylinder, either vertical or horizontal, one meter in diameter and two meters in length, situated near the generators, and by the side of the feed-engine.

The water condensed in the double bottoms and worms of the different apparatus is conducted here by pipes. From this reservoir the feed-pump supplies the boilers. It is provided with a glass tube indicator, to mark the water level, and with a supply-cock, by which small quantities of cold water may be introduced from time to time to compensate for the loss occurring from leakage and other causes.

In the boiler room another reservoir of sheet iron is placed, which is supplied with steam direct from the generators. From this reservoir the steam required for the different operations of the factory is taken.

EXTRACTION OF THE JUICE.

WASHING THE BEET ROOTS.

In all large sugar factories, elevators similar to those before des are used to lift the beets from the ground to the washing machine

The washing apparatus used is exactly similar to that used pr tory to the process of distillation, and before described in Chapte the size varying according to the size of the factory.

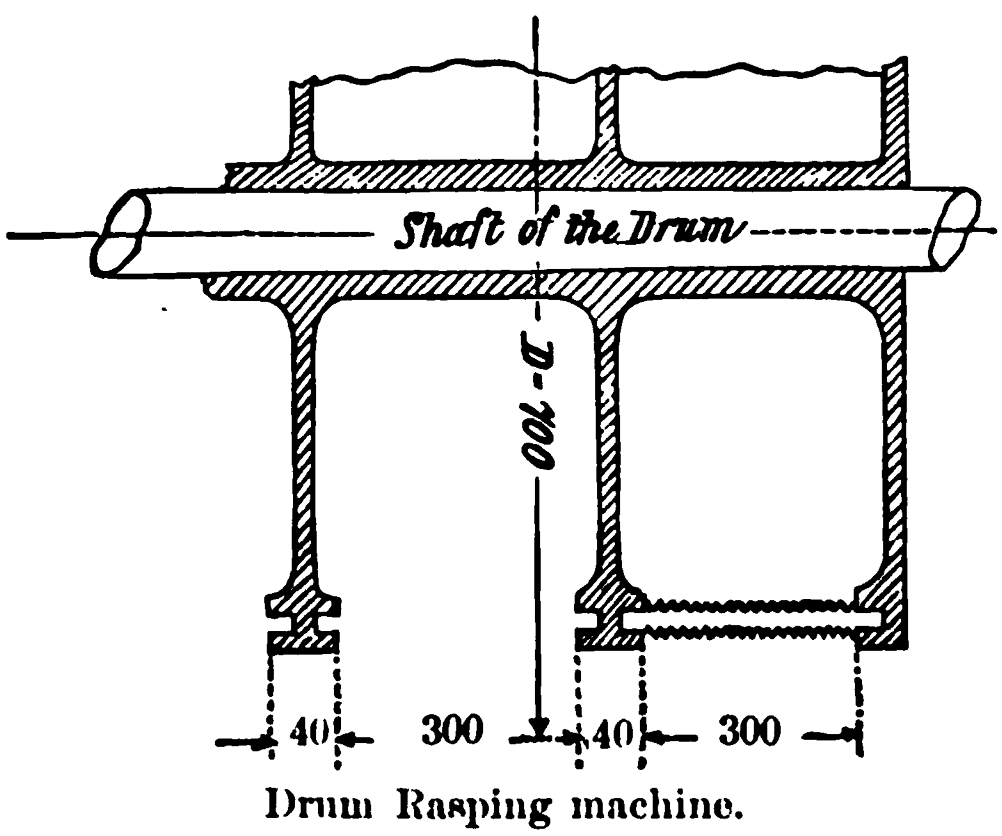
The washing machine is usually placed in the beet store-house, the amount required for a night's work is stored up. It is elevated the ground, so that the beet root, when washed, may pass by an in plane directly to the rasping machine.

The mud from the washing machine is conducted away, in the m above described, to be utilized for manure.

RASPING MACHINES.

M. Champennois has constructed a rasping machine, on the same ciple as his horizontal centrifugal root-cutter, but in spite of the results obtained from it, and its low price, it is not yet generally u

Fig. 6.



Drum Rasping machine.

Beets are rasped in a all factories by means drum rasping machine drum, which is divid cast-iron disks into three, or four partition meter wide, according amount of beet to be r is 0.700 meter in dia Each of the disks is pr with a circular groove meter wide, and 0.010 deep; into these groov inserted the tenons c blades.

The steel blades are cut with sharp teeth on both sides, so that, worn on one side the other may be used. They are halved into e the partitions of the drum so that the tenons of the blades fit in circular grooves. A small lath of wood, eight millimeters thick, is p between the blades and is held by tenons. The cast-iron frame supports the drum and driving wheel is provided with a cast-iron per, which has as many partitions or conduits as there are partiti the drum. These conduits lead down to the cutting surface of the and in each of them there is a contrivance for pushing forward th roots upon the rasp. This consists of a cast-iron block or follower, is made to move to and fro by means of a lever. As the beets fall

into the hopper and the conduits, this block presses them up against the rasping surface.

The whole drum is covered with a light jacket of sheet-iron to prevent the pulp being thrown out. On its upper part there is a small gutter perforated by holes to distribute a thread of water, which is brought over the whole surface of the drum for the purpose of cleaning the set of teeth of the blades, and extracting at the same time a part of the sugar by "endosmosis."

The pulp, as it comes from the drum, is carried to large and flat reservoirs called pulp-troughs.

The velocity of the drum should be from nine hundred to a thousand revolutions per minute. By giving a greater velocity to the drum, and causing the drivers to advance slowly, the beet is more perfectly torn, and finer pulp is obtained. It is always necessary to have a spare drum, which can be used when the teeth of the drum generally used are broken and injured by the small stones which are always found in the beet. In this manner prolonged delays are avoided.

PRESSING.

For pressing out the juice both the screw press and hydraulic press are used: the first for the less powerful or first pressure; the second where it is necessary to apply great force.

Each screw press is tended by four men, who take the pulp as it comes from the rasps, shovel it into bags, subject it to the first pressure, and pass it to the hydraulic press. The work is done very rapidly, the system of division of labor greatly facilitating the operation.

Of late, in some factories, a labor-saving shoveling machine has taken the place of hand labor. It consists of an iron shovel of from six to eight liters capacity, which plunges by a vertical rectilinear alternate motion into the pulp, becomes filled with it, lifts it up and empties it into a bag stretched out for the purpose by the bag tender.

SCREW PRESS FOR THE FIRST PRESSING.

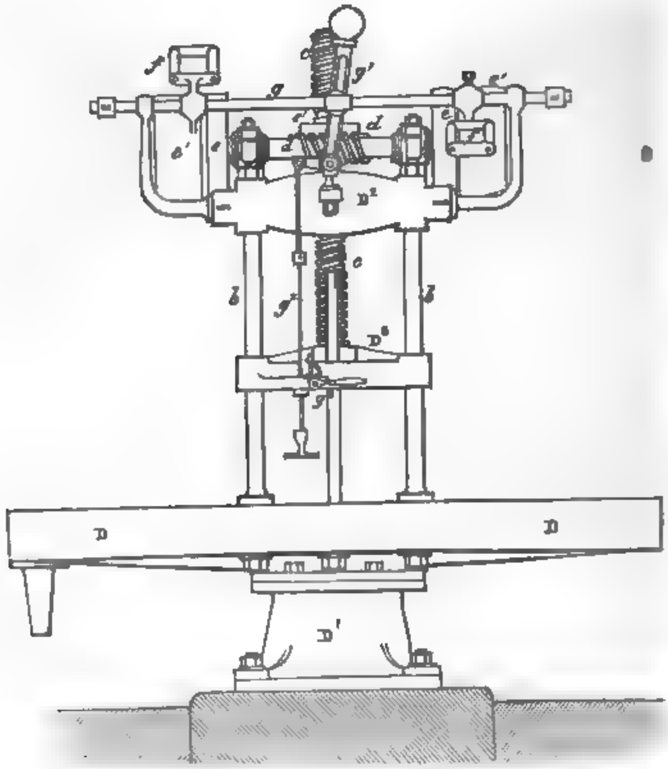
The first pressing is effected with great rapidity in screw presses made of iron, and the construction of which is shown by the annexed figures in plan and in elevation.

These presses have a cast-iron table or bed-plate D, 2.20 meters long by 1.10 meter wide. The upper surface is grooved to receive the expressed juice and convey it to the spout at one side. This bed is raised above the general level of the floor upon a pedestal of cast iron, with flanges, by which the whole press is firmly secured to a foundation.

The upper plate and the screw is supported by four cylindrical columns *b b*, which are bolted into the rectangular frame D^2, and they serve as guides to the movable bed D^3. The screw has a double thread, and is 0.120 meter in diameter. It works in a nut of copper *c*, the periphery of which gears into a horizontal endless screw *d'*. This screw is sup-

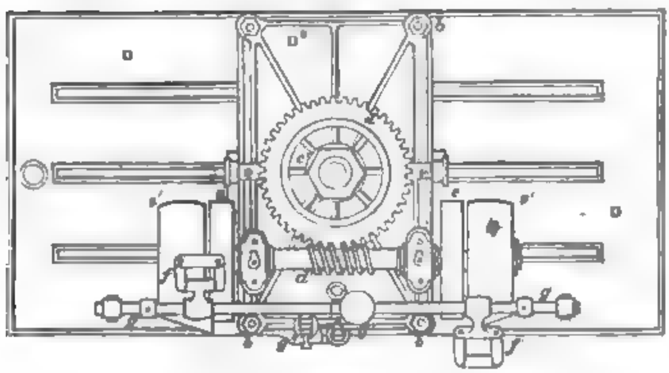
ported upon pillar blocks attached to the frame D^2, and it extends bey the bearings on each side so as to receive fast and loose driving pul

Fig. 7.



Screw press—Elevation.

Fig. 8.



Screw Press—Plan.

e and *e'*. These driving pulleys *e* are 0.08 meter wide and 0.325 meter *diameter*, and the loose pulleys are 0.16 meter wide. By this arrangeme

he screw may be made to turn in either direction up or down at will. The ransfer of the belts from the fast to the loose pulleys, or the reverse, is effected by guides $f\,f'$ attached to the rod g, which may be slid back and forth by the weighted lever g' controlled by the attendant by means of the vertical rod g^2. This rod is held securely in its proper place by means of a spring catch g^3.

The pulp having been placed in woolen bags, these are piled upon the bed of the press and are separated by hurdles. When the upper plate is reached the belt is thrown upon the proper pulley and the plate decends rapidly until the required pressure is obtained. The bags are then removed to the hydraulic presses for the final and much more powerful pressing.

THE HYDRAULIC PRESS.

The hydraulic presses used are vertical; the cast-iron cylinder is 1.230 meter high, including the base, 0.525 meter in diameter outside, and 0.100 meter thick. The piston is a hollow rod turned truly cylindrical and 0.300 meter in diameter. The upper and lower parts of the body of the press are connected by four rods. During the operation of pressing, the pile of half-pressed pulp bags as they come from the screw presses is sustained in vertical position by means of side rods of iron passing through the upper and lower plates. From forty to forty-five bags may be heaped upon the press at once.

A screw-press can generally work up six tons of beets in twenty-four hours, and supply four hydraulic presses. Two, three, or four of these screw-presses are used, and eight, twelve, or sixteen hydraulic presses, according to the size of the factory.

In pressing with the hydraulic press the platform is made to rise slowly, giving sufficient time for the juice to run off. When the juice is observed to run too freely the communication between the injection pump and press is interrupted, and a valve is opened which lets the water into the injection-pump tank. The platform of the press slowly descends and the bags are removed by the "slack-man," together with the iron hurdles which are placed between them. From six to eight minutes is the time usually allowed for submitting the beets to hydraulic pressure. The bags are then carried to the pulp-shop, emptied and returned to the first pressure workmen at the screw-press. These bags are made of coarse woolen yarn; as they are frequently torn by the pressure to which they are subjected, a number of women are constantly employed in mending them. After being used, they are washed in hot water, rinsed and dried.

The hurdles which are placed between the bags are made of hoop-iron 0.025 meter wide and one and a half millimeter thick, twisted and riveted together so that the spaces between the bars shall be 0.025 meter wide, the width of the bars themselves. Sheet-iron plates have been tried, but they do not permit so free a flow of juice, and are more likely to tear the bags.

INJECTION-PUMPS FOR HYDRAULIC PRESSES.

Every factory must have one or two sets of injection-pumps, arranged in such a manner that one of them is used whenever the press is put in operation. These pumps are actuated by means of shafts with excentrics and connecting rods. They are under the superintendence of one man, who connects the pump with its press whenever it is to be used.

The hydraulic press, the construction of which is familiar to all, has a piston 0.300 meter in diameter, and is capable of exerting a pressure equal to one hundred and fifty atmospheres per square centimeter of the surface piston, which amounts to a total pressure of about one hundred tons.

By the first pressure, with the screw-press, from thirty-five to forty per cent. of the beets' weight of juice is obtained; by both pressures, from seventy-eight to eighty per cent., leaving in the form of pressed pulp only from twenty to twenty-two per cent. of entire weight of the beet.

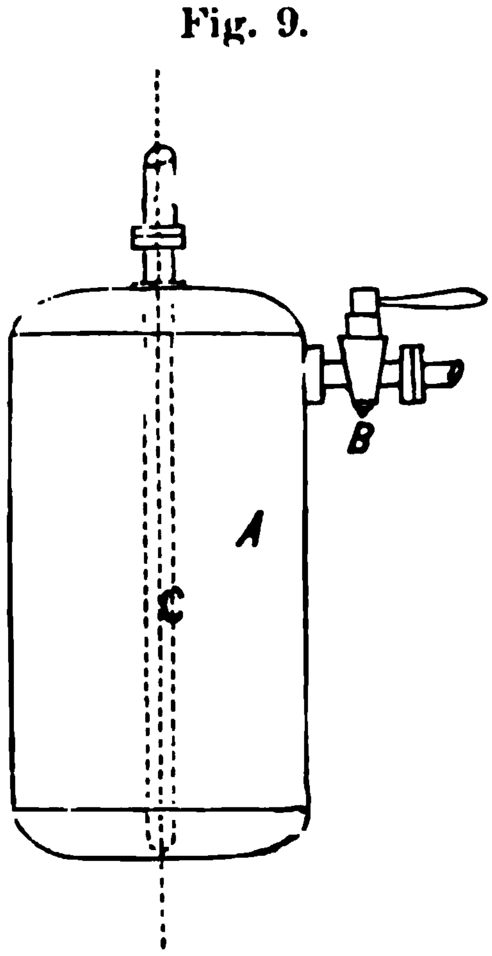
The steam-engine, by means of bands and pulleys, actuates, first, the drum of the beet rasp; second, the first pressure screw-press; third, the hydraulic press injection-pumps, and by means of a small pulley keyed to one of the fly wheels actuates also, but at a slower rate, the rasp drivers, the shoveling machine, the beet-washing machine, and the beet elevators.

JUICE REFINING.

JUICE ELEVATOR.

The juice from the screw-presses and hydraulic presses is conducted by a gutter of sheet iron to the juice elevator.

Fig. 9.



Juice Elevator.

This apparatus is composed of a sheet-iron cylinder A, capable of resisting a pressure of from five to six atmospheres; its capacity is determined by the size of the boiler into which it forces the juice. The juice from the presses is let in through the pipe and cock B. When the elevator is filled, the cock B is closed and a jet of steam introduced through a cock set above the cylinder A. The pressure of the steam forces the juice through the inside tube C up to the boilers which are placed on an upper floor. A three-way cock is placed above the elevator, by which the steam can be let in, and which being turned in the opposite direction allows it to escape. The gutter which conducts the juice from the press to the elevator is of dimensions sufficient to allow a considerable quantity of juice to collect, so that when the elevator is emptied, which operation requires only two minutes, it can be filled again immediately.

All juice elevators are similar to the one described, and vary only in ize.

DEFECATION.

Although this operation is now almost entirely displaced by other rocesses, it may be briefly referred to as it was formerly conducted. he juice must be first clarified, and as soon as possible heated, in order) prevent the spontaneous alterations which are liable to take place in e liquid, which still contains the nitrogenous matters favorable to the evelopment of fermentation. Before commencing this operation the mperature of the juice is raised to sixty degrees centigrade. Lime is rgely used for the purpose of clearing the juice of the foreign matters ntained in it.

The lime neutralizes the free acids contained in the juice, unites with e gummy matter—the albumen—and forms with these substances soluble compounds. It eliminates also the fatty and coloring matters, d decomposes the salts of ammonia, potash, and soda. The insoluble bstances in the juice, such as the fragments of cells, are carried off ith the foam, which is composed largely of albuminate of lime, thus arifying the liquid. A portion of the lime unites with the juice and rms saccharate of lime. The amount of lime used varies according to e quality of the beet and the season at which the operation is perrmed. In the beginning of the season five kilograms of lime are sually used for every thousand liters of juice, but as the season adances, and towards its close, the amount may be increased to ten kilorams, owing to the alteration which takes place in the beet. Milk of me is used for this purpose, containing twenty kilograms of lime to e hectoliter.

The defecation boiler is a cylindrical vessel of copper, from two to ree millimeters thick, having a hemispherical bottom, outside of which other bottom is placed, leaving a space between the two for the circution of steam. The boiler is provided with a steam supply-cock, a ck for drawing off the water condensed from the steam in the double ttom, and a discharge-cock. The boiler is filled from one of the juice evators. Steam is then introduced into the double bottom, and the mperature of the juice is raised to from sixty to seventy degrees centiade. The milk of lime is then added, and thoroughly mixed with the ice. The mixture is thus brought to the boiling point, and on the first ullition the supply of steam to the double boiler is stopped. If the boilg were to continue the foam would be disturbed, and the liquid become ick and muddy. A good defecation is indicated by a clear appearance the liquid, and by the rapid collection of foam of a greenish brown lor, detached from the sides of the boiler, and marked with small fisres the instant the boiling begins. Whenever the defecation is not companied by these indications, and particularly when the juice is t limpid, the amount of lime should be varied. To obtain a successful efecation, therefore, under all circumstances, a superabundance of lime

is added, which, however, can be separated from the sugar by lowing operations:

Beneath the defecation boilers two sheet-iron gutters are plac of which receives the clear juice, the other the foam. When th tion, which lasts from twenty-five to thirty minutes, is ended, charge-cock is opened. That portion of the juice which is thi muddy is carried off by the foam gutter, while the clear juice ducted to the boilers for the first carbonation. The muddy ju foam from the defecation boilers, as well as the foam from the fi bonation boilers, is collected in a reservoir, and is subsequently by the foam or filter press. After each operation the boiler is c These boilers contain generally from fifteen to twenty hectoliters boilers of twenty hectoliters each are sufficient for a factory whicl up two hundred tons of beet root in twenty-four hours. The pro first carbonation will be hereafter described.

DOUBLE CARBONATION.

The discovery of this method of refining the juice is due to M rier and Possoz. It consists in the employment of larger quanti lime than before used, and of carbonic acid gas.

By this method the beet juice can be perfectly refined, a large in animal charcoal at the same time being effected. The juices in this way evaporate and crystallize in baking, without forming reous deposits on the heating surface. By this method, also, more is produced, which is of a finer quality, and better to the taste th produced by the old system.

It is estimated that the introduction of this method has eff saving of eight per cent. in the cost of the sugar. Inventor endeavored to so direct the operation as to produce the maximun with the minimum amount of lime. They have graduated the ef this agent by means of successive additions, so that the lime is b in contact with the juice, which has been to a certain extent clari each preceding reaction.

Formerly defecation was performed as above described, the clea being afterwards subjected to the first carbonation, but now the ing method is preferred, which does away with defecation and tl chinery used for that purpose, while a more perfectly refined pr and more easily compressible foam is obtained.

CARBONATION BOILERS.

The boilers for the first and second carbonation are placed side l upon the same floor. Above them a hood, surmounted by three draught chimneys, is placed, through which the gases and vapors gaged during the operation escape. Above the boilers the carbon gas supply-pipe passes, which is furnished with cocks by whic requisite amount is distributed to each boiler. The boilers are s

the dimensions from two meters to 2.20 meters. They are made of sheet iron, and will hold about sixty hectoliters each. The usual quantity with which they are filled is about forty hectoliters, this space being left to prevent the foam which is formed during the process, as well as the juice, which is disturbed by the action of the carbonic acid gas, from overflowing.

Every boiler is provided, first, with a copper heating worm, by means of which the juice is raised to the required temperature. Second, with a carbonic acid gas distributor or "dabble," made of pipes in the shape of a cross, or of a spiral, and placed 0.05 meter from the bottom of the boiler. These pipes are perforated with holes six millimeters in diameter, through which the gas is let into the boiler. Third, with a discharge-pipe at the front of the boiler. The bottom of the boiler is inclined so that all the juice may readily escape through this pipe, which leads to the wash-troughs. Fourth, with a cock, 0.02 meter in diameter, by which a jet of steam can be thrown from time to time into the gas "dabble," to prevent the holes with which it is perforated from becoming stopped up.

WASHING TROUGH.

To every boiler a washing trough of sheet iron is attached, which has the same length as the boiler; its width and height being determined by the amount of juice each boiler is to receive. Each trough is furnished with a discharge-cock, which is placed about 0.10 meter from the bottom. Sometimes there is arranged outside of the trough, and corresponding with the cock, an India-rubber pipe, to the end of which a float is attached, so that as the juice runs out the float follows the level of the liquid. In the middle of the bottom of the trough a series of cast-iron tubes is arranged, through which the sediment and foam is discharged into a gutter which runs under the bottom of the troughs, and leads to the foam presses and filters.

After each operation the boilers and washing troughs are carefully cleaned; the steam worm is also cleaned with sandstone grit; steam is also injected into the gas "dabble," to free the hole from dirt.

MUDDY OR FIRST CARBONATION.

The process of defecation, now out of use, has been supplemented by a process known as muddy carbonation, which consists in mixing the juice as it comes from the presses with lime. The quantity of lime used is from fifteen to thirty kilograms per thousand liters of juice. The milk of lime is mixed with the juice in the juice elevator. To accomplish this a small reservoir containing the required amount of milk of lime is above and connected with the juice elevator. The juice thus mixed with the lime is raised by the juice elevator to one of the boilers of first carbonation, into which the carbonic acid gas is pumped, and when the larger part of the lime is carbonated, the temperature is raised

to between sixty and seventy degrees centigrade, the carbonation meanwhile continuing. The proper degree of carbonation is recognized by the matter held in solution in a sample of this muddy juice being readily precipitated; or, when one volume of this muddy juice, on being mixed in a test tube with two volumes of the proof liquor No. 1, a drop of this mixture brought in contact with the ferro-metric standard liquor produces a green spot on a piece of white sized paper.

The first carbonation must be stopped exactly at this point, by closing the carbonic acid gas supply-cock, at which time the temperature of the juice is raised to between ninety and ninety-five degrees centigrade. About fifty or sixty minutes are required for this operation, when the boiler contains forty hectoliters of juice. These conditions have been determined by the following facts, which have been learned by observation:

First. It is advantageous to carbonate the larger part of the lime at a temperature below sixty degrees centigrade, in order to prevent the albumenized and pectic matters from becoming soluble, as they are easily dissolved by the action of a large quantity of lime, and at a temperature a little above sixty degrees, thereby producing viscous compounds which retard the crystallization of the sugar.

Second. Besides the formation of these viscous matters, there will be, when the juice mixed with the milk of lime is heated nearly to the boiling point, a precipitation, together with the foam in the form of saccharate of lime of a certain quantity of sugar.

Third. If the first carbonation is pushed further than the limits above indicated, the coloring and viscous matters, which have been already precipitated, would again become dissolved. The advantage obtained by stopping the carbonation at the proper point would thus be lost.

Fourth. If the carbonation is stopped too soon, the juice will not be homogeneous, the deposit will be badly formed, and the filtration will be rendered difficult.

It is therefore essential to carefully regulate this operation.

As soon as the carbonation is finished, the whole contents of the boiler must be emptied into the wash trough corresponding to it, there being one to each boiler. In the course of from fifteen to twenty minutes the juice, being clarified, is emptied by means of the discharge-cock into a gutter which leads to a juice elevator, by which it is lifted up to the second carbonation boilers.

A small sheet-iron reservoir, furnished with a linen strainer, or a layer of bone-black, is sometimes placed before the juice elevator, so as not to render it necessary to send the juice to the second carbonation boiler when it has been imperfectly decanted and contains particles of sediment, which would be easily dissolved again by the carbonic acid gas required for the second carbonation.

The sediment or foam precipitated to the bottom of the wash-trough

is diluted with the wash-water of the boilers, and discharged into the gutter which leads to the foam shop.

SECOND CARBONATION.

The decanted juice, as well as that which comes from the foam press, is lifted by a juice elevator to the second carbonation boilers.

A small reservoir placed above the juice elevator contains the requisite amount of milk of lime to be mixed with the juice. The mixture is made in the juice elevator, the amount of lime varying from two to ten kilograms per thousand liters of juice, according to its quality. As soon as the boilers are filled, the whole is brought to a boiling point for a few moments, and the carbonation is effected by introducing carbonic acid gas.

The second carbonation is known to be completed, first, when the "curcumine" paper is not turned red on contact with the juice; second, when one volume of the muddy juice, on being mixed with two or three volumes of the proof liquor No. 2,[1] produces a white spot on contact with the ferro-metric liquor. Another easy method of determining this result is, (when there is sufficient light,) by mixing in a perfectly clean glass nearly equal portions of muddy juice and No. 1 proof-liquor. If any lime in a free state remains in the juice, the mixture will assume a greenish gray color, and the carbonation must be continued. If there is a large amount of free lime still remaining in the juice, the mixture retains the color of the muddy juice, yellowish white without the green shade.

In this case the carbonation must be continued one or two minutes longer, in order to obtain a perfect result.

The boiling is to be continued after the second carbonation for about five minutes, in order to expel the carbonic acid, after which from one to two-thousandths of slack-lime water is introduced. The object of this is to precipitate any organic fermentable matters dissolved anew by the surplus carbonic acid. This addition, moreover, makes the juice slightly alkaline during filtering. After filtering, however, no trace of lime can be found, as it is entirely absorbed by the animal charcoal. The contents of the boiler are then emptied into the corresponding wash-trough In the course of twenty minutes the clear juice is decanted, as was done in the first carbonation, and the precipitated sediments are carried to the foam shop, and mixed with the similar products of the first carbonation.

When the foam becomes excessive, during the first and second carbonation, its violence may be diminished by injecting into the boiler a small quantity of grease.

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[1] The proof liquor No. 1, by which the stopping point of the first carbonation is determined, is obtained by mixing twenty-four parts of water with a solution of prussiate of potash. The proof liquor No. 2, by which the completion of the second carbonation is determined, is prepared by mixing two hundred parts of water with one part of the same solution. The ferro-metric liquor is a solution of chloride of iron.

FILTRATION.

GRANULATED ANIMAL CHARCOAL FILTER.

The juice, which now has a specific gravity of from five to six degre Beaumé, is filtered through animal charcoal. This filter is a sheet-i cylinder one meter in diameter, and 2.50 meters in height, open at t top, and furnished with a double bottom of sheet iron six millimet thick, perforated with holes 0.010 meter in diameter, and 0.06 me apart from center to center. This double bottom is supported at a di tance of 0.05 meter from the bottom of the filter, by angle irons. door 0.35 meter square, placed on the level of the double bottom, serv to take out the animal charcoal when it no longer decolorizes the ju Over the double bottom a common linen strainer is spread, and ov this is poured from twelve to fifteen hectoliters of granulated ani charcoal. Sirup at twenty-five degrees Beaumé, or juice at five or degrees, is introduced at the top of the filter, and it percolates thro the whole mass of animal charcoal, issuing through a pipe at the b tom, which rises as high as one-half the filter's height, where a cock placed, which discharges the filtered juice or sirup to their respecti gutters.

When the filter is filled with fresh animal charcoal, sirup at twe five degrees Beaumé flows from the evaporators through the filter twelve hours, after which time the flow of sirup is stopped, and t decanted juice from the second carbonation at five or six degre Beaumé flows through the filter for twenty-four hours longer. At t expiration of this time the animal charcoal will no longer effect a deco oration. The flow of juice is then stopped, and cold water introduce to expel the juice remaining in the mass of animal charcoal, and is dis charged through the cock into the filtered-juice gutter. The flow is co tinued until the specific gravity of the water issuing from the filte marks zero. The flow of water is then stopped. That which still re mains in the mass of animal charcoal is discharged through a cock the bottom of the filter, and the charcoal is removed and revivified b a process which is described beyond.

Six filters of the dimensions above described are sufficient for a facto working up two hundred tons of beet root in twenty-four hours. T filtered juice is raised by a juice elevator to the reservoir, from whi the evaporating apparatus is supplied, and which is placed above Instead of the juice elevator, another contrivance, called the *aspirat* is sometimes made use of. It is composed of a sheet-iron cylinder o capacity of thirty hectoliters, in which a vacuum is produced. It placed upon the same frame as the evaporating apparatus, and so what over it; a pipe, furnished with a cock, leads from this to the tered-juice reservoir, which is placed on the ground floor. When t vacuum is produced, the cock is opened, and the filtered juice rises, f the apparatus, and flows from them to the evaporating pans.

EVAPORATION.

TREBLE-ACTION VACUUM EVAPORATING APPARATUS.

The principle of this machine is founded upon the utilization of the latent heat of the steam, which is so managed as to pass over several liquids successively, and evaporate them. It is necessary that the different liquids to be evaporated should be under different pressures, so that their boiling points will be at different temperatures.

The evaporation being *in vacuo* at a low temperature, the alteration of the sirups is less marked than if carried on under the ordinary atmospheric pressure, and at a high temperature.

The apparatus is composed of, first, three tubular boilers of cast iron, similarly constructed; second, of two safety vessels, of cast iron; and third, of a cast-iron condenser, which is also a safety vessel. See Plate III.

The boiler consists of a tubular shank, the tubes of which are made of brass, 0.05 meter outside diameter, and 1.20 meter long between the plates by which they are connected, which are made of bronze. Under the lower tubular plate a cast-iron bottom is fixed, and over the upper plate a cylindrical cover 1.50 meter high. This is provided with a man-hole, by which the boiler can be entered and the boiler tubes cleaned, which is done with a steel scraper whenever washing with acidulated water is insufficient. The boiler bottom is provided with a two way cock by which the sirup and water used in cleaning the boiler can be discharged into their respective gutters. The upper part of each boiler is provided with a glass tube indicator for ascertaining the level of juice; with a double eye-glass for looking into the interior of the boiler; with a proof apparatus for ascertaining the density of the sirup; with a cock to introduce air, and also butter, in order to diminish the ebullition of the sirup when it is too violent; with a vacuum indicator; and, finally, with a steam-cock for the introduction of steam for cleaning the interior of the boiler. The juice from the feed reservoir is introduced through the top of the first boiler by means of a cock. The second boiler is provided with a similar cock to bring it in communication with the first. The third boiler is likewise furnished with a cock to bring it in communication with the second. The second and third boilers are furnished each with a cock through which the juice from the first and second safety-vessel is introduced into them respectively. The tubular shank of the second boiler is provided with a cock which brings it into communication with the third boiler shank; while the third boiler is put into communication with the condenser by means of a similar cock. Each tubular shank has at the bottom a return pipe, through which the condensed water is discharged. The discharge-pipe from the first boiler leads to the condensed water tank; while from the second and third boilers it leads to the exhaust-pipe of the air-pump, which produces the vacuum in the apparatus.

The escape-steam from the engines, which is under a pressure of one and a quarter atmospheres, and at a temperature of one hundred and six degrees, is forwarded to the reservoir H, from which it is conducted into the tubular shank of the first boiler A. There it is conveyed into the tubes which are immersed in the juice to be evaporated. From this boiler the air is exhausted, so as to create a vacuum indicated by a column of fifteen or twenty centimeters of mercury, and thus in this boiler the boiling and evaporation of the juice takes place at a temperature below one hundred degrees. The steam from the juice in the first boiler passes through the inside tube of the safety-vessel B into the tubular shank of the second boiler B, this steam being at a temperature of from ninety to ninety-five degrees centigrade. The air in the second boiler is exhausted so as to create a vacuum, indicated by from forty-five to fifty centimeters of mercury. The boiling and evaporation of the juice is here done at a temperature of from eighty to eighty-five degrees centigrade. The steam from the juice of the second boiler passes through the inner tube of the safety-vessel E into the tubular shank of the third boiler C, in which a vacuum is created at from seventy to seventy-two centimeters of mercury. The boiling and evaporation of juice in this boiler is done at a temperature of from sixty-five to sixty-eight degrees centigrade. The steam from the third boiler, passing over to the condenser F, is condensed by a shower of cold water injected through the pipes *ii*. The hot water obtained by this condensation passes through the pipe J to the air-pump G, which creates the vacuum in the apparatus, and is thrown out. The water from the tubular shanks of the second and third boilers is conducted through the pipes *ff* into the pipe which leads to the air-pump.

When the surface of the tubes of the second boiler does not condense all of the steam passing from the juice in the first, the cock which connects the tubular part of the second boiler and the third boiler is opened so that the surplus of steam may pass into it. If all the steam is not condensed by the surface of the tubes in the third boiler, the cock is opened, which allows the steam to pass into the condenser F. By regulating the cocks, the required vacuum will be maintained in each of the boilers. In beginning this operation the juice is brought from the reservoir I through the pipe *b* to the first boiler, and through the connecting pipes *c* and *d* to the second and third boilers. The third boiler is filled as high as above the upper tubular plate; the air-pump is set in motion, and the escape-steam from the engines is introduced through the pipe into the tubular shanks of the first boiler A.

As the juice becomes more concentrated, a portion of it is allowed to pass from the second to the third boiler, and from the first to the second, fresh juice being introduced into the first boiler from the reservoir I. The operation is thus continued, the juice being maintained at a level of [illegible] meter above the upper tubular plate. Throughout the whole oper

ation the discharge-cocks of the first and second boilers remain closed, the juice being drawn off through that of the third boiler.

When it is ascertained by the proving apparatus that the juice in the third boiler is reduced to a sirup of the proper consistency, the specific gravity of which is twenty-five degrees Beaumé, the cock *m* of the juice elevator K is opened, through which is emptied, through the pipe *g*, a portion of the sirup of the third boiler, without, however, reducing the level so as to uncover the tubular plate. The juice then passes from the boiler B to the boiler C, and from the boiler A to the boiler B, a fresh supply of juice being introduced from the reservoir I into A. The operation is thus continued, by introducing fresh juice into A, and drawing off the concentrated juice from C.

In order that the sirup may pass from the boiler C into the juice elevator K, a vacuum is produced in the latter equal to that in the boiler by means of the cock and pipe connecting it with the condenser F. When the juice elevator is filled, steam is introduced, which forces the sirup into a boiler, where it is again heated before filtration. The specific gravity of the juice in the different boilers is ten, eighteen, and twenty-five degrees Beaumé.

When the operation is finished, and it is desired to clean the apparatus, the juice is concentrated in the first and second boilers at a higher density than above indicated, the discharge-cocks are opened, and the contents of the three boilers are poured into the juice elevator. The boilers are washed with acidulated water of two degrees specific gravity. They are filled so as to cover the tubes and the apparatus is worked as if filled with juice. When the operation is completed the acidulated water is discharged through a pipe similar to the pipe *g*. Pure water is then introduced into all the boilers in order to rinse them. This is brought to the boiling point, as before described, after which the boilers are emptied and are ready for a fresh supply of juice.

Cleaning is done once or twice a week, depending on the amount of sediment deposited by the juice.

Every week the inside of the tubes must be cleaned with a steel scraper, to remove the incrustations not removed by the acidulated water. Care must be taken to scrape the tubes of the third boiler, as the incrustations form more rapidly there than in the other two.

BOILER FOR REHEATING THE SIRUP.

The sirup at twenty-five degrees Beaumé passes from the juice elevator K into a rectangular boiler, containing a brass worm, placed near the carbonation boilers. Here the sirup is heated to ninety degrees centigrade, after which it passes to the animal charcoal filters which are operated as above described. The filtered sirup is then collected in a reservoir of the capacity of fifty liters, placed on the ground floor, from which it is conducted to the apparatus for crystallization.

CRYSTALLIZATION.

At twenty degrees Beaumé the juice takes the name of sirup. With out mentioning the salts of potash, soda, &c., the sirup contains sixty six per cent. of sugar to thirty-three of water, and will not crystal lize when it contains more than fourteen per cent. of water. To obtai crystallization, therefore, it is necessary to concentrate the sirup stil further. This operation is called "baking."

Until within a few years these two operations of baking and crysta lizing have been distinct. The baking having been done, the siru was put into large troughs of sheet iron, where, being left undisturbe for a week or fortnight, it crystallized—that is to say, it separated itsel into solid, or rather moist sugar and "first molasses." The troughs, th labor, the necessary buildings, the temperature which it was necessary t maintain in the evaporating rooms, constituted a very heavy expens Suddenly a process was discovered by which crystallization could b performed at the same time as the roasting or baking. The result i that the expensive apparatus and the large number of workmen formerl required have been done away with. Five troughs now do the work o a hundred, and a work-shop of one hundred and fifty to two hundre superficial meters is large enough for a factory which consumes on hundred and thirty tons of beets per day.

This operation is called baking in grains, and it is the only metho now in use. Wherever baking in grains is done Howard's apparatus, c a slight modification of it, is used.

The following is from a description which M. Cail gives in his notic of it:

"The sirup at twenty-five degrees Beaumé coming from the evapo ating apparatus must be concentrated under particular conditions t bring it to the proper roasting point.

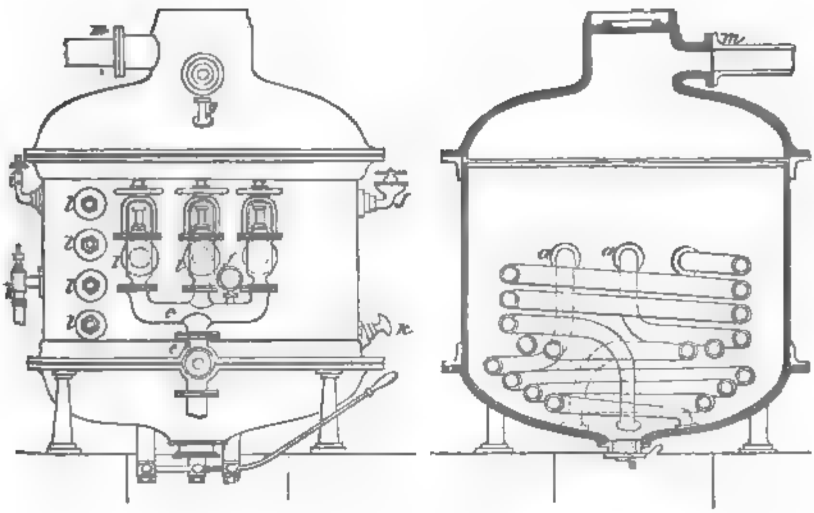
"It is necessary to prevent the transformation of a part of the suga into molasses, and not to subject the sirup to too high a temperatur This is done by creating a vacuum in the baking apparatus of fro sixty to sixty-five centimeters of mercury.

"It is necessary also, in order to form the grains in the roasting app ratus, to obtain in the first roasting a sirup of the same consistency a that obtained in ordinary roasting. The operation is then continued b introducing into the apparatus, from time to time, small quantities c sirup. This being at a different temperature, lowers the temperature c the sugar which has just been brought to the boiling point, and cause crystallization to take place.

"The baking apparatus displayed at the Exposition, which is co structed according to the specifications of a patent of the 22d of May 1860, answers all purposes in the most complete manner. It is furnishe with three worms into which can be introduced successively and sepa rately the steam which is employed for baking the sirup.

"The object of this is that, inasmuch as the grains which are formed have a tendency to sink and cover the bottom of the heating apparatus with crystals of sugar, which are bad conductors of heat, the ebullition of the sirup which covers the crystallized sugar may be accomplished by the upper worms. The introduction of steam into the worms, successively, commencing with the bottom one, has the advantage of not having the heated surfaces in contact with the liquid, and prevents caramelization, which would be produced on these surfaces.

Fig. 10. Fig. 11.



Exterior. Interior.
Apparatus for baking in grains.

"This system gives excellent results. The sugar produced by this method is more easily refined, more beautiful, and furnishes a larger per cent. per hectoliter of the sirup than can be produced in any other way. All the beautiful specimens of sugar which were displayed at the Exposition by Perrier, Possoz, and J. F. Cail & Co., were roasted in grains in this apparatus. The "bull's eyes" with which the machine is furnished, as high as the worms, permit the workman to keep himself informed of the progress of the operation. The machine on exhibition can produce sixty hectoliters of sugar baked in grains in one operation, which lasts eight hours, with juice well refined by the process of Perrier and Possoz. It is constructed of sheet, or cast-iron, with worms of red copper, and can be used with equal facility for beet root or cane sirup.

"Three hundred of these machines of different sizes are in operation to-day in the sugar districts, where they are set up by the firm of Cail & Co."

The following is a more complete description of this machine and its method of operation. It s represented by the accompanying figures, showing the exterior and the interior. Figs. 10 and 11.

The boiler is made in three sections. A cast-iron cover, provid with a man-hole, so that the interior can be cleaned; a cylindrical mi dle portion of the same material, and a cast-iron bottom furnished wi an emptying valve. A tube passing from the upper part of the cov allows the steam generated by the evaporation of the sirup to escap which is conducted by the pipe *m* to a condenser similar to that attach to the boilers of triple effect. A vacuum of seventy centimeters of me cury is created in the boiler by means of an air-pump similar to th above described.

In the interior of the boilers three worms are placed *a*, *a*, *a*, into whi steam is separately introduced through the cocks *b*, b^1, b^2.[1] These coc are joined together by means of the forked pipe *c*, into which the stea enters from the generators through the cock *d*. The water caused b the condensation of the steam in the worms passes to the condense water reservoir. Every boiler is provided, first, with a manometer *f*, t determine the pressure of the steam; second, with a vacuum indicator *g* third, with a cock *h*, through which the sirup passes to the filtered sir reservoir; fourth, with the air-cock *i*; fifth, with the cock *j*, by whic small quantities of butter are introduced to stop the ebullition when i becomes too violent; sixth, with the probe line *k*, to ascertain the roast ing in the middle of the mass contained in the boiler; seventh, wit four "bull's eyes," so as that the interior of the boiler may be seen fro without.

In beginning the operation the air-pump is set in motion, and a vac uum is created in the boiler; the cock *h* is opened and a quantity o sirup sufficient to cover the first worm is introduced; the steam-cock is then opened. As the volume of the sirup is reduced by evaporatio small quantities of fresh sirup are from time to time let in through th cock *h* so as to keep the first worm always covered. The concentratio is thus continued until the crystals begin to form. Immediately smal quantities of fresh sirup are introduced, which prevents the crystal already formed from melting, produces further concentration, and en larges the crystals already formed. When the second worm a^1 is cov ered, steam is introduced through the cock b^1. The operation continue in this manner, small quantities of fresh sirup being introduced unti the whole heating surface is covered.

Through the "bull's eyes" *l*, *l*, *l*, *l*, the increase of the crystals is visi ble, and the degree of concentration of the mass is from time to tim determined by the probe *k*.

The concentration is continued until the boiler is filled to the level o the top of the cylindrical part of the boiler. From eight to ten hours i usually necessary to roast forty hectoliters.

When the operation is finished, the air-cock *i* is opened to allow th entrance of air into the boiler, and the air-pump is stopped. The empty

[1] Marked, by error, *l l* in the figure.

ing valve *n* is then opened and the whole roasted mass is conducted through a gutter into shallow sheet-iron reservoirs of the capacity of from forty to sixty hectoliters each.

At the end of from eight to twelve hours the roasted mass becomes cool, and the crystallization is completed.

The process of purifying the sugar then follows.

PURIFYING THE SUGAR BY TURBINES.

The roasted mass is freed from the sirup by means of turbines. Many of these were shown in the French section. The following is a description of their construction and method of operation.

The construction of one is shown in section in Fig. 12:

From thirty to forty kilograms of the roasted mass is diluted with sirup at twenty-five degrees Beaumé in order to obtain a homogeneous paste free from lumps. This paste is thrown into the drum of the turbine, which makes about twelve hundred revolutions per minute. By the centrifugal force the sirup is thrown out through the wire gauze with which the interior of the drum is lined, while the crystals are retained in the drum.

In the course of four or five minutes, from two to three liters of sirup at twenty-nine degrees Beaumé, called *clairée*, is poured into the drum. This liquid drives out all the sirup which remains in the sugar, and is itself driven out through the wire gauze. This operation continues three or four minutes, when a thin thread of steam is injected into the drum for a minute through a pipe the end of which has been split for a short distance with a saw. The turbine is then stopped and the sugar is taken out by means of a small copper shovel. The liquid thrown out is arrested by the outer casing, and runs out by an opening at the side.

The sugar thus obtained, which is called "sugar of the first run," is white, formed in large crystals, and is in a state to be sent immediately to market.

THE SECOND RUN OF SUGAR.

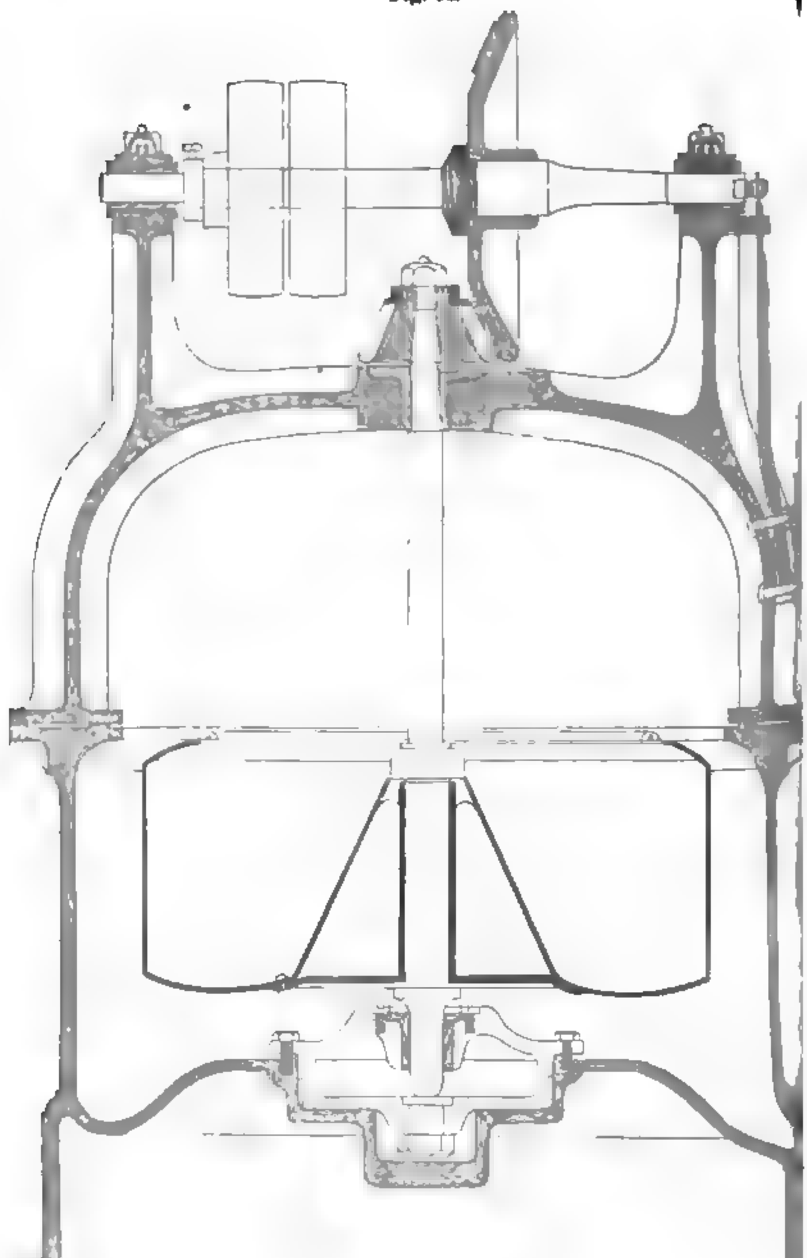
The sirup from the turbine is collected in a reservoir and from thence pumped into the baking apparatus. This sirup is subjected to the same operation as above described for filtered juice, a less perfect crystallization, however, taking place.

When the roasting is accomplished the mass is transferred through a gutter to large sheet-iron reservoirs of two hundred liters capacity, situated in buildings in which the temperature is raised to from forty to fifty degrees centigrade either by means of a furnace or heated steam pipes. Here crystallization takes place in the course of from fifteen to twenty days, at the end of which time the sugar is in a condition to be brought to the turbines for refining, which is performed as above described. The sugar thus obtained is called sugar of the "second run," and is not of the same whiteness as that first obtained.

THIRD RUN OF SUGAR.

The sirup of the second run issuing from the turbines is also su jected to the roasting process as above described. No crystals are, ho

Fig. 12.



Turbine for freeing the sugar from sirup—Section.

ever, formed in the boiler owing to the poverty of the sirup in sugar. When the baking is finished the mass is conducted to a large reservoir of the capacity of four hundred liters situated in the same building as the reservoirs for the second run. In the course of three or four months the crystallization is accomplished, and the sugar is purified in the manner above described, omitting, however, the introduction of a jet of steam into the turbines, which would melt the crystals, as only very small ones are produced in this last crystallization.

The sirup which is thrown out by the turbine working on the third-run sugar supplies molasses which can be distilled for alcohol. The residuum of this distillation is used for the manufacture of potash.

Four turbines are sufficient for a factory which works up two hundred tons of beet root every twenty-four hours. These machines are actuated by a six horse-power engine driving no other machinery.

SCUM PRESS.

The scum from the different boilers is mixed together, and carried in common linen bags, tied up at one end to a reservoir and allowed to drain for some time. The bags are then ranged on the platform of a screw press, and submitted to a pressure by hand, hurdles being placed between the bags in the same manner as described in pulp pressing.

The juice thus obtained passes to the second carbonation boilers, together with the decanted juices of the first carbonation.

The contents of the bags are then emptied and are used as manure.

Within a few years filter presses have been substituted for hand presses with good results.

PURIFYING AND DECOLORIZING.

LIME FURNACE.

The furnace or kiln used for making the lime is shown in vertical section in Fig. 13, and in horizontal section at the height of the fireplaces by Fig. 14.

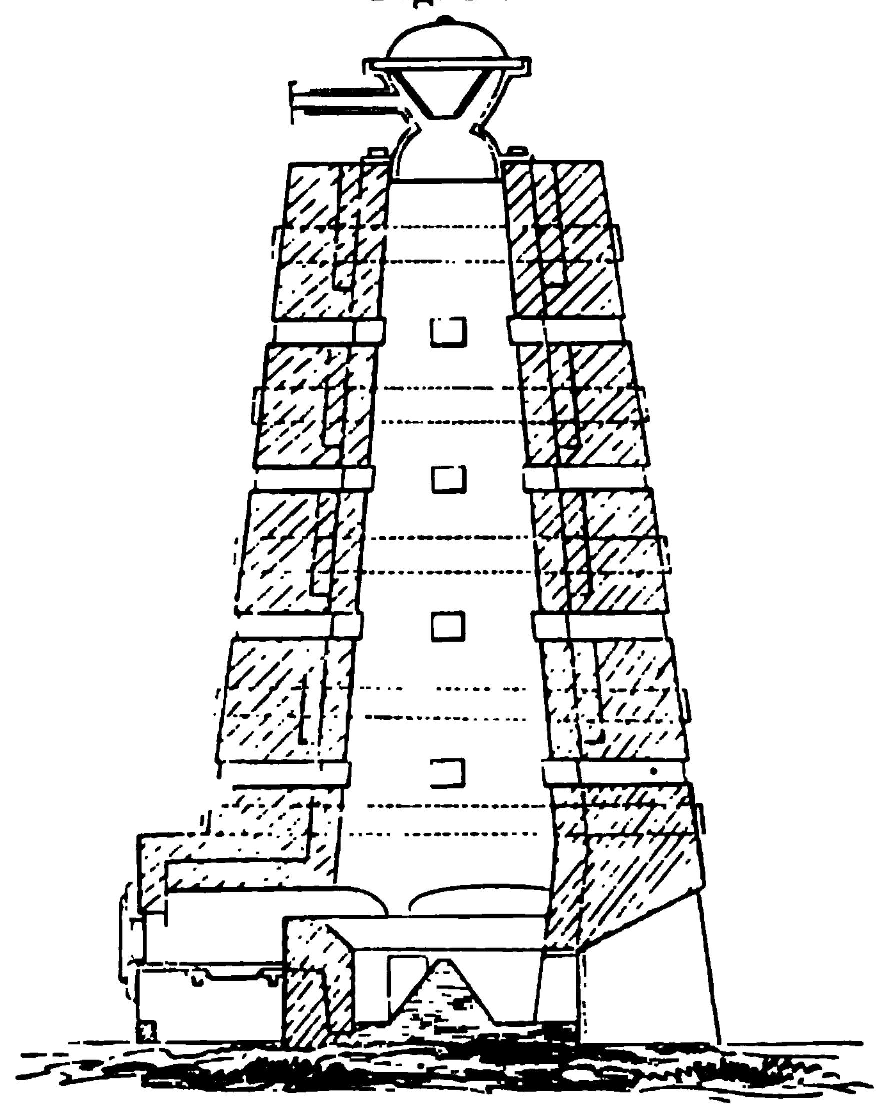
It is 1.50 meter in diameter at its base and 5.75 meters in height, and is furnished with three fireplaces placed at equal distances around the circumference and immediately under the cavity of the furnace into which they open.

The outside is built of common brick surrounded with iron hoops. The inner walls, which are 0.22 meter thick, are built of fire-brick. The fire grates are 0.620 meter long by 0.40 meter wide, and have cast-iron platforms 0.30 meter wide placed before them. Between the fireplaces there [are] wide openings through which the lime is taken out, and which are hermetically closed during work by doors of cast iron. Good coke or pure pit coal is used for fuel, and care must be taken not to use any fuel

containing sulphur, which would cause incrustations of sulphate of lime in the boilers.

The furnace is filled from the top, which is surmounted by a cast-iron cupola, in the interior of which a sheet-iron funnel, closed hermetically by a cover of the same material, is set up, which rests on a bank covered with a layer of water or of sand.

Fig. 13.

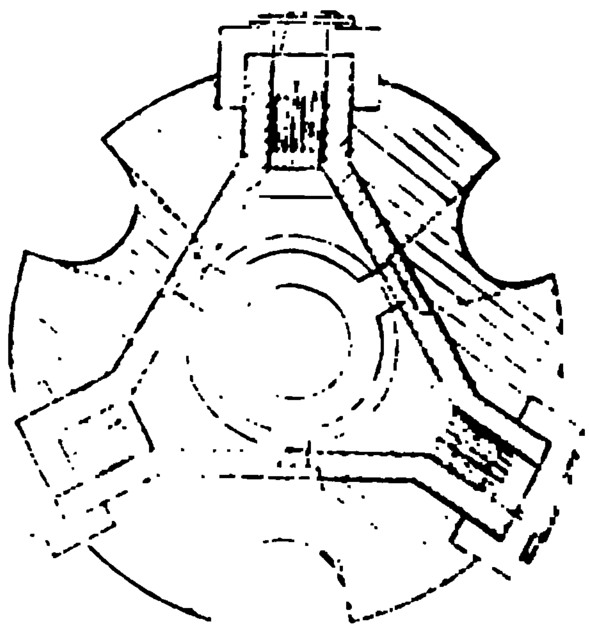


Lime Furnace or Kiln—Vertical section.

A certain quantity of coke or of charcoal is also mixed with the limestone, care being taken to select that quality which contains no argillaceous matter, in order to prevent the boiler pipes from becoming incrusted.

It is necessary, also, in order to obtain well-baked lime and carbonic acid, to fill the furnace with small quantities of limestone from time to time, and to remove it as soon as baked; once in every five or six hours is often enough.

Fig. 14.



Lime Furnace—Horizontal section.

It is estimated that five cubic meters of limestone will produce four cubic meters of lime per day. The consumption of coke is about eighteen hectoliters at the hearth, and about eight hectoliters of washed coke in the interior of the furnace.

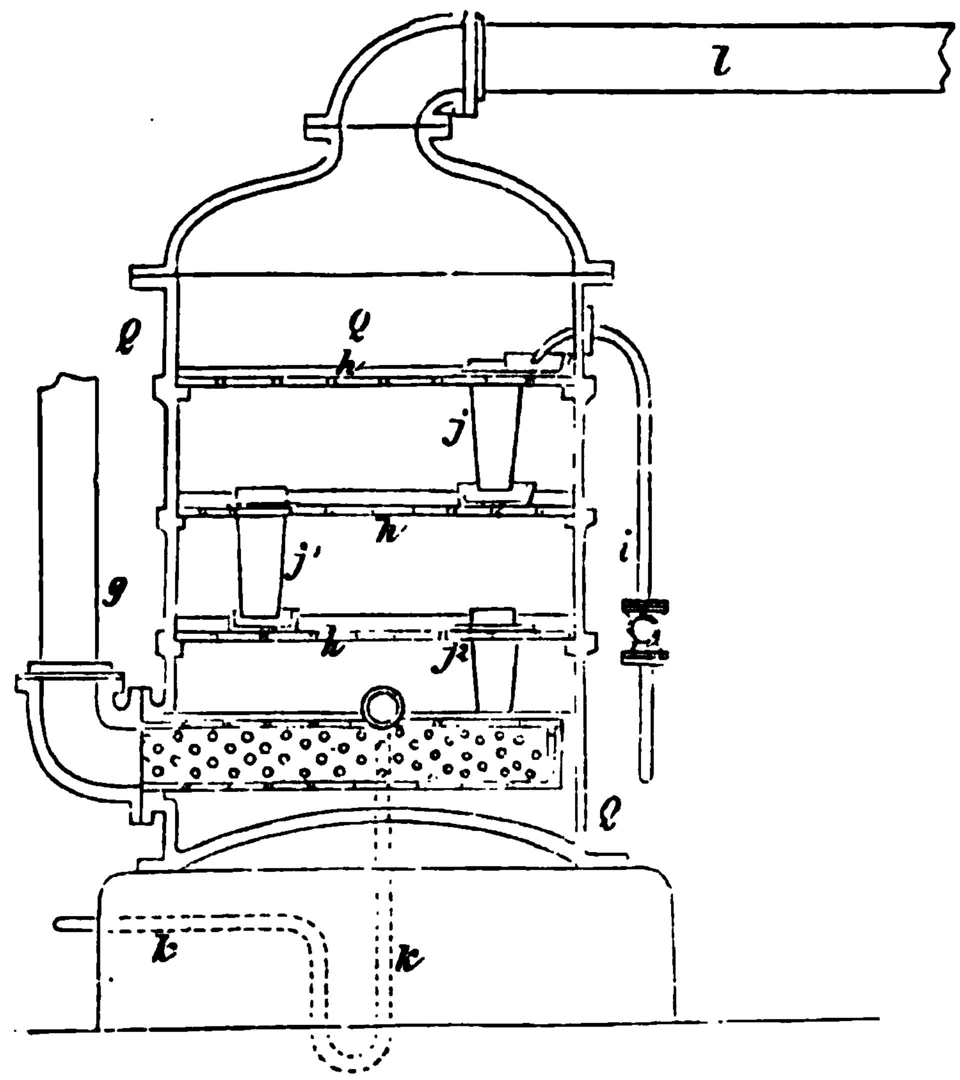
The gas, as it is disengaged from the lime, ascends to the top of the furnace and passes through the pipe to the washer, where it is cooled and purified previous to being used.

GAS WASHER.

This apparatus, represented in vertical section by Fig. 15, page 83, is composed of a large cylinder, Q, of cast iron, hermetically closed, the interior of which is divided into four compartments by horizontal diaphragms *h*, perforated with small holes eight millimeters in diameter and five centimeters apart. A stream of water is conducted by a cock and pipe *i*, communicating with an upper reservoir to the top partition, and runs downwards from one partition to another through a series of pipes j, j^1 and j^2, so arranged as to allow only a thin covering of water, 0.05 meter in depth, to remain over each of the diaphragms.

The carbonic acid gas conducted to the lowest partition of the cylinder by the pipe *g* is washed by passing through the successive layers of water and makes its exit at the top of the washer. The water charged with gas and some particles of ashes having become gradually heated is discharged through a pipe bent in the form of an inverted siphon.

Fig. 15.



Apparatus for washing the carbonic acid gas—Section.

About forty liters of cold water at twelve degrees centigrade is sufficient to wash and cool at the same time sixty cubic meters of gas, which, when it passes into the water, is at the temperature of three hundred degrees centigrade, and when discharged is at a temperature of about fifty-five degrees centigrade.

The gas then passes through the cast-iron pipe *l*, which has the same diameter as the inlet pipe *g*, to a reservoir, from which it is pumped into the carbonation boilers. A common force-pump is used for this purpose.

PREPARATION OF LIME-WATER.

It is necessary that there should always be a large supply of lime-water on hand. The solution used has the strength of twenty kilograms of lime to every hectoliter of water.

For this purpose two sheet-iron reservoirs of the capacity of five hundred liters each are prepared. Into each, one hundred and ten kilograms of lime are thrown and slacked so as to form a thick milk. Water, or, better, juice from the first carbonation, is then added until the milk of lime is sufficiently diluted. In this way the addition of water to the juice is prevented, a very fluid lime-water being at the same time obtained. Water or juice to the amount of five hundred liters—the capacity of the reservoir—is added as required.

Before use the lime-water is strained through wire gauze to free it from any impurities or foreign matters contained in the lime. An allowance of one-tenth in weight is made for these impurities in the amount of lime used.

The strained lime-water is kept for use in a reservoir provided with a

paddle, which is moved from time to time to prevent the lime in suspension from settling.

WASHING AND REVIVIFICATION OF ANIMAL CHARCOAL.

For washing the animal charcoal two machines are used, the tub furnished with spattles and the steam tub. The first washing tub is composed of a semi-cylindrical trough of sheet iron 0.50 meter in diameter and three meters in length, supported by two legs. An iron shaft armed with sheet-iron spattles, the whole forming a screw, traverses it longitudinally. This shaft makes from twelve to fifteen revolutions per minute, and is actuated by means of a pulley keyed to the end. The animal charcoal is thrown into the trough at the end opposite the pulley; the screw throws it from one spattle to another, at the same time carrying it towards the other end of the trough. Here a cock is placed through which is introduced a stream of cold water, which flows in a direction opposite to that in which the animal charcoal is moving, and passes out at the end of the trough where the charcoal is introduced. The trough is inclined so as to facilitate the flow of the water.

THE ANIMAL CHARCOAL STEAM TUB.

The animal charcoal, on coming from the spattle-trough, is thrown into a closed sheet-iron cylinder of twenty hectoliters capacity, furnished with a double bottom similar to that described for filters. The cylinder is filled by an opening at the top and an emptying door like that of the filters serves to take out the animal charcoal.

The cylinder being filled, a jet of steam is introduced, which, traversing the mass of animal charcoal, is condensed and passes out in the form of water.

All the impurities in the charcoal are removed by this washing, which lasts from fifteen to twenty minutes.

The reservoir is then emptied and the animal charcoal is subjected to vivification in a tubular furnace.

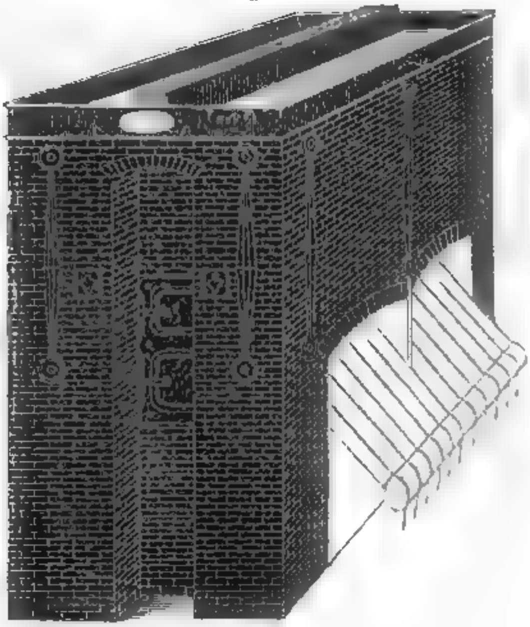
ANIMAL CHARCOAL VIVIFYING FURNACE.

The vivification is effected in apparatus of various kinds. There are some manufacturers who still use ordinary cast-iron kettles, in which the charcoal is heated to a red heat. As this operation is a long one and needs much room, a tubular furnace, in which the vivification is continual, is generally preferred.

The furnace contains twenty-four cast-iron pipes or long boxes, the rectangular sections of which are 0.20 meter by 0.10 meter; they are placed slantingly on each side of the longitudinal axes of the furnace. The top is provided with a sheet-iron hopper, connecting with the boxes in which the charcoal is heated, and discharged at the bottom. See Fig. 16.

The charcoal from the steam wash-tub is thrown into the hopper; thence it passes to the upper part of the pipes or boxes where it is heated. It becomes gradually more heated as it advances along the pipes, the vivification being effected at a red heat. As it advances further the pipes, which extend outside of the brick-work, become cooled by contact with the air or by sprinkling cold water, and the charcoal is removed from the bottom.

Fig. 16.



Furnace for the Revivication of Animal Charcoal.

Every quarter of an hour the bottom of each pipe is opened successively, and from ten to fifteen liters of vivified or refrigerated bone-black is taken out. That portion already in the tube descends and takes the place of that removed. Fresh charcoal is then thrown into the hopper, and the operation is continued.

Care must be taken that no animal charcoal runs out when red hot, as it burns and becomes white on contact with the air, and loses its power of decolorizing.

The vivified animal charcoal is again used in the filters. A grate of from 0.40 meter to 0.50 meter in width runs the whole length of the pipes, which are placed above it. The fuel generally used is coke from the gas-works. A twenty-four pipe furnace is sufficient to vivify the charcoal used in a manufactory working up two hundred tons of beet root in twenty-four hours.

GAS-LIGHTING APPARATUS.

As a general thing, the factories are lighted by gas, which is manufactured in the establishment, the coke which is produced being used for the animal charcoal furnaces. A factory working up two hundred tons of beet root in twenty-four hours would, in all the buildings, offices, lodgings, &c., require sufficient to supply two hundred burners.

LIST OF PRINCIPAL EXHIBITORS OF MACHINER USED IN THE PRODUCTION OF SUGAR AND ALCOHOL FROM THE BEET ROOT.

FRANCE.

M. M. BLAISE.—Furnace for revivifying the animal charcoal used i decolorization.

BOUR & CHENAILLIER.—Generator applicable to sugar-cane factorie

BRIEZ SONS.—Material for pulp-sacs.

CAIL, J. F., & Co.—Entire sugar factory. A mill for sugar-cane, wi three rollers, a beet rasp, a first pressure table, a hydraulic pre carbonic acid bellows, a turbine, a centrifugal pump, an apparat of triple effect, a boiler for baking the sugar *in vacuo*, a tubul boiler, a condenser, an air pump, a Wetzel boiler, a Biedel & Schmi filter press, a sugar mill.

CAMICHEL & Co.—An apparatus called osmogene, of M. Dubrunfau with samples of products.

CHAMPENNOIS, H.—A beet-rasp.

CHENAILLIER, P.—An apparatus for evaporating and cooking the sug in the open air, and at a low temperature, an apparatus for bakin *in vacuo.*

DUFOURNET & Co.—Forms for sugar in hard pasteboard.

FARINAUX, BAUDET & BOIRE.—An apparatus of triple effect, an ai pump, carbonic acid bellows, filter press for foam.

HERMION.—Animal charcoal mill.

HEROUART, E.—Material for pulp sacs.

JOLY & CAMUS.—Machine for cleaning the roots and freeing them fro stones, and a beet rasp.

LEFEBVRE.—An apparatus for baking.

LEGAL, F.—An apparatus for cooking *in vacuo.* Molds in steel.

LINARD.—Plan and designs of apparatus for transporting to distanc the beet juice by means of subterranean pipes.

MARIOLLE.—Centrifugal rasp.

MOLINOS, PRONNIER & DION.—Pulp press.

PHILIPPE.—Pulp press.

RIEUX & ROETTGER.—Filter presses for pulp and foam.

ROBERT DE MASSY.—Pulp press.

SALABRE DELCOUR.—Material for pulp sacs.

ZAMBAUX & NILUS.—An apparatus of triple effect.

BELGIUM.

CAIL, J. F. HALOT & Co.—Apparatus of triple effect.

DORZÉE & ANDRY.—Beet rasp, turbine and designs.

ANCOURT—FILLER.—Molds of sugar and forms made of lacquered heet iron.

PRUSSIA.

RS, J.—Apparatus of double effect for evaporation; apparatus for fining *in vacuo*.
LINGER.—A turbine.

AUSTRIA.

D & LHUILLIER.—Molds for sugar in galvanized iron.
FELD & EVAUR.—Evaporating apparatus and air-pump.
S. (*Filature de.*)—Material for pulp pags.
EIN.—Parchment used in sugar factories.
G, CH.—Molds for sugar in papier mâché.
.—Fabrics for the presses of a factory.
CEK.—Mold for sugar.
T.—Extraction of sugar by diffusion.
SY & SPITZ.—Combed woolen fabrics for the presses of a sugar ctory.
AYER.—Vacuum for sugar factories.
the above exhibitors, Messrs. Cail & Co. were the only ones who d the award of a gold medal.

ESCRIPTIVE REFERENCES TO THE PLATES.

PLATE II.

ITUDINAL SECTION OF A DISTILLERY WORKING UP THIRTY-SIX OUSAND KILOGRAMS, THIRTY-SIX TONS, OF BEETS EVERY TWENTY-OUR HOURS.

Locality for the maceration, fermentation, distillation, and rectifying apparatus.
Locality for the motor, the steam generators.
Beet storehouse.
Pit for mixing the pulp with cut hay.
Boxes to contain the mixture of pulp with cut hay.
Barn space to receive the beet wash-house, the hay cutter, and to serve as forage magazine.

Beet-root elevator.
Beet washing machine.
Trough for receiving the mud from the washing machine.
Trough to carry the washed beet, from the washing machine to the root-cutters.

5. Root-cutters.
6. Tank to receive the slices of pulp from the root-cutter.
7. Maceration tub.
8. Tank for the weak juice.
9. Refrigerator of juices going to the fermentation vats.
10. Fermentation tubs or vats.
11. Cistern to receive the fermented juices or wines, (not shown in section.)
12. Draining well of the cistern from which the wine pump draws the fermented juice.
13. Wine pump.
14. Water pump.
15. Weak-juice pump.
16. Wine reservoir.
17. Cold water reservoir.
18. Acetic vinegar refrigerator, (not shown in section.)
19. Distillation boiler.
20. Distillation column of the distillatory apparatus.
21. Wine heater of the distillatory apparatus.
22. Refrigerator or condenser of the distillatory apparatus.
23. Boiler, (not shown in section.)
24. Rectifying column of the rectifying apparatus.
25. Condenser of the rectifying apparatus.
26. Refrigerator of the rectifying apparatus.
27. Measure-gauge table of the distillatory and rectifying apparatus.
28. Phlegm reservoir feeding the rectifying boiler.
29. Reservoir for the bad quality alcohol.
30. Reservoir for the middling quality alcohol.
31. Reservoir for the fine quality alcohol.
32. Decanter for filling the barrels.
33. Steam generators, (one of them not in use.)
34. Steam-engine with feed pump.—Not shown.
35. Small feed pump for generators.—Not shown.
36. Escape-steam reservoir.—Not shown.
37. Condensed-water reservoir.
38. Transmission of motion to the pumps, the washing machine, the beet elevator, and root-cutter.
39. Transmission of motion to the hay cutter and hay elevator. (At the end of this shaft a pulley is placed, transmitting movement by means of a wire cable to the threshing machine set up in a building about thirty meters from the distillery.—Not shown.)
47. Steam pipe and cock of the distillation boiler.
50. General weak-juice feed-pipe of the maceration tubs.
55 Compression tube of pump forcing weak juice into the reservoirs.
59. Pipe conducting the juice out of the refrigerator to the fermentation *tubs*.

60. General communication pipe for cutting the liquid in the fermentation tubs.
61. Pipes from fermentation tubs emptying into the cistern.
62. Suction pipe of the water pump.
63. Force pipe of water pump.
64. Suction pipe of wine for draining well of the cistern.
65. Force pipe of the wine pump in the wine reservoir.
66. Pipes and cocks to conduct the acetic vinegar from the boiler either direct to the tubs or to the acetic vinegar refrigerator.
67. Pipes and cocks introducing water to be employed in washing the distillation and rectification boilers.

PLATES IV AND V.

GROUND PLAN AND LONGITUDINAL SECTION OF A SUGAR MILL CAPABLE OF WORKING UP TWO HUNDRED TONS OF BEETS EVERY TWENTY-FOUR HOURS.

A. Beet storehouse.—Not shown.
B. Rasping machine.
C. Apparatus for carbonation, filtering, evaporation, and baking.
D. First run of sugar.
E. Second and third runs.
G. Wash-room for the sacks or bags.
H. Room for the treating the scum or foam.
I. Steam generators.
J. Animal charcoal filters.
K. Preparation of lime water.
L. Room for the engineers.

1. Wash-room for the beets.
2. Inclined plane leading the beets from the washers to the rasp.
3. Rasp.
4. Pulp troughs.
5. Screw press for the first pressure.
6. Hydraulic presses.
7. Force pumps for the hydraulic presses.
8. Steam-engine driving the rasps.
9. Gearing of the rasping apparatus.
10. Juice elevator, raising the juice from the presses to the chambers of the first carbonation.
11. Carbonation.
12. Troughs for separating the slime of the chambers of first carbonation.
13. Gutters leading the juice from the first carbonation to the juice elevator 14.
14. Juice elevator, lifting the juice from first to second carbonation boilers.

15. Chambers of the second carbonation.
16. Slime separating troughs for the chambers of the second c tion.
17. Gutters leading the juice from the second carbonation to th
18. Filters.
19. Reservoir for the filtered juice.
20. Reservoir for the filtered sirup.
21. Elevator lifting the filtered juice from evaporating apparatu
22. Evaporating apparatus.
23. Safety chambers for the evaporating apparatus.
24. Injecting condensers for the evaporating apparatus.
25. Juice elevator emptying the evaporation boiler and feeding the re-heater.
26. Boiler for re-heating the sirup.
27. Boilers for baking in grains.
28. Injecting condenser for the baking boilers.
29. Machine for carbonic acid gas.
30. Air-pump creating the vacuum in the evaporation apparatu
31. Air-pump creating the vacuum in the baking boilers.
32. Receptacles for the juice of the first run.
33. Receptacles for the juice of the second and third runs.
34. Turbine for cleaning the sugar.
35. Steam-engine actuating the gearings.
36. Reservoir receiving the sirups from the rotary pump.
37. Gearing of the turbines.
38. Gearing of the water pump.—Not shown.
39. Rotary pump supplying the mill with water.—Not shown.
40. Reservoir of water supplying the mill.
41. Heating pipes for juice of second and third runs.
42. Troughs for washing the bags.
43. Presses for the scum or foam.
44. Boilers.
45. Steam receptacles of the boilers.
46. Exhaust steam reservoir.
47. Condensed water reservoir.
48. Driving engine.
49. Animal charcoal washing-machine.
50. Animal charcoal steam washers.
51. Revivifying animal charcoal furnace.
52. Slacked lime reservoir.
53. Elevator conveying lime water to reservoir 54.
54. Reservoir for clarified lime water.

PLATE II

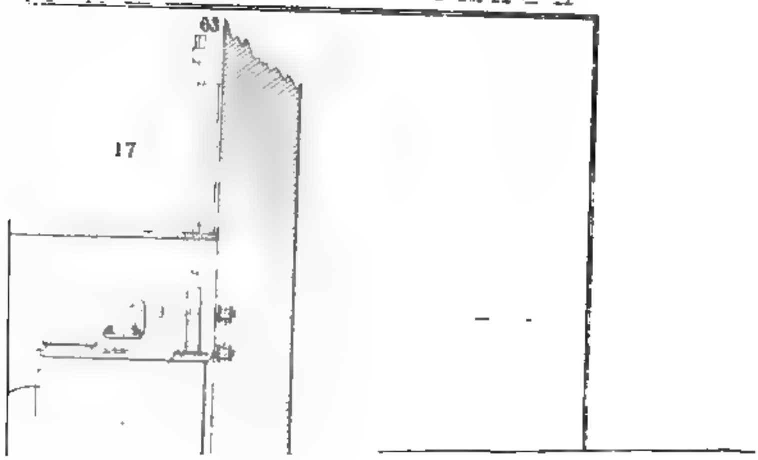


PLATE 2

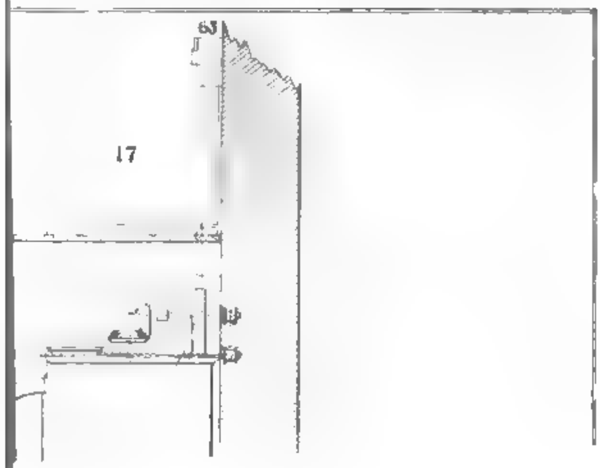
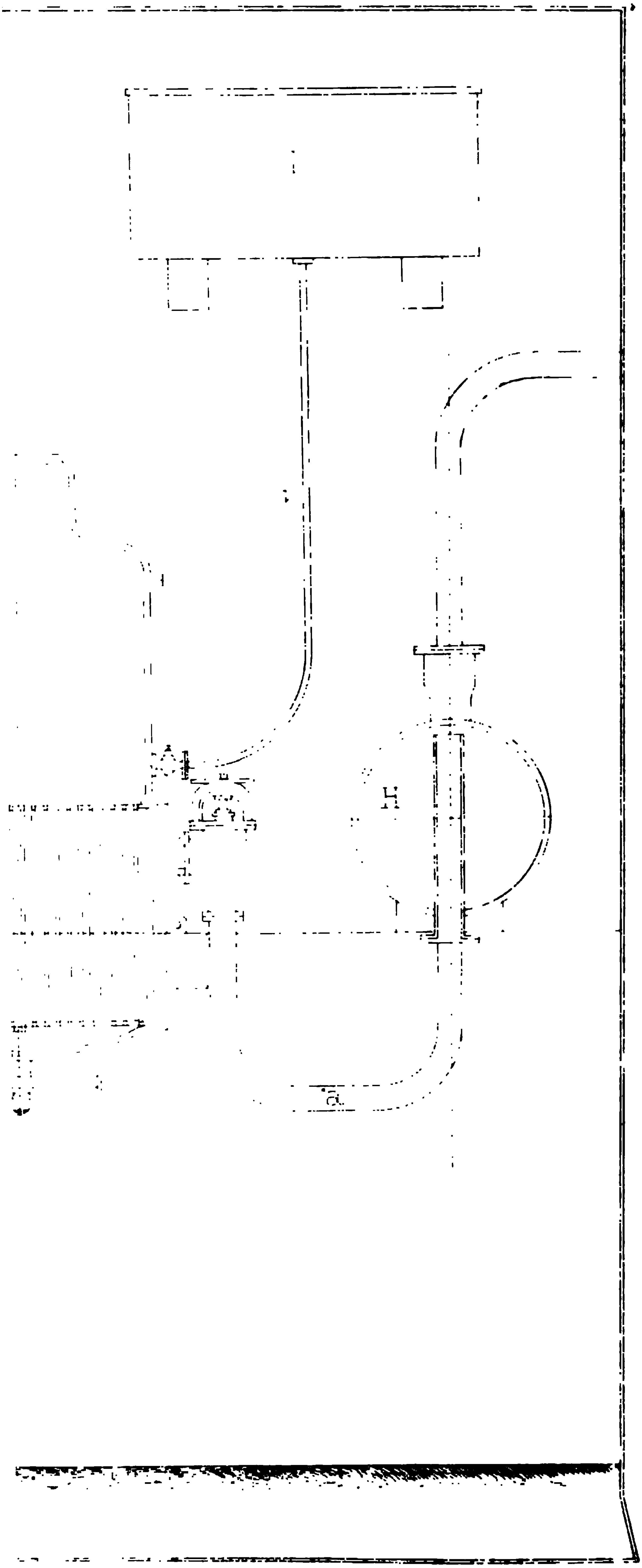
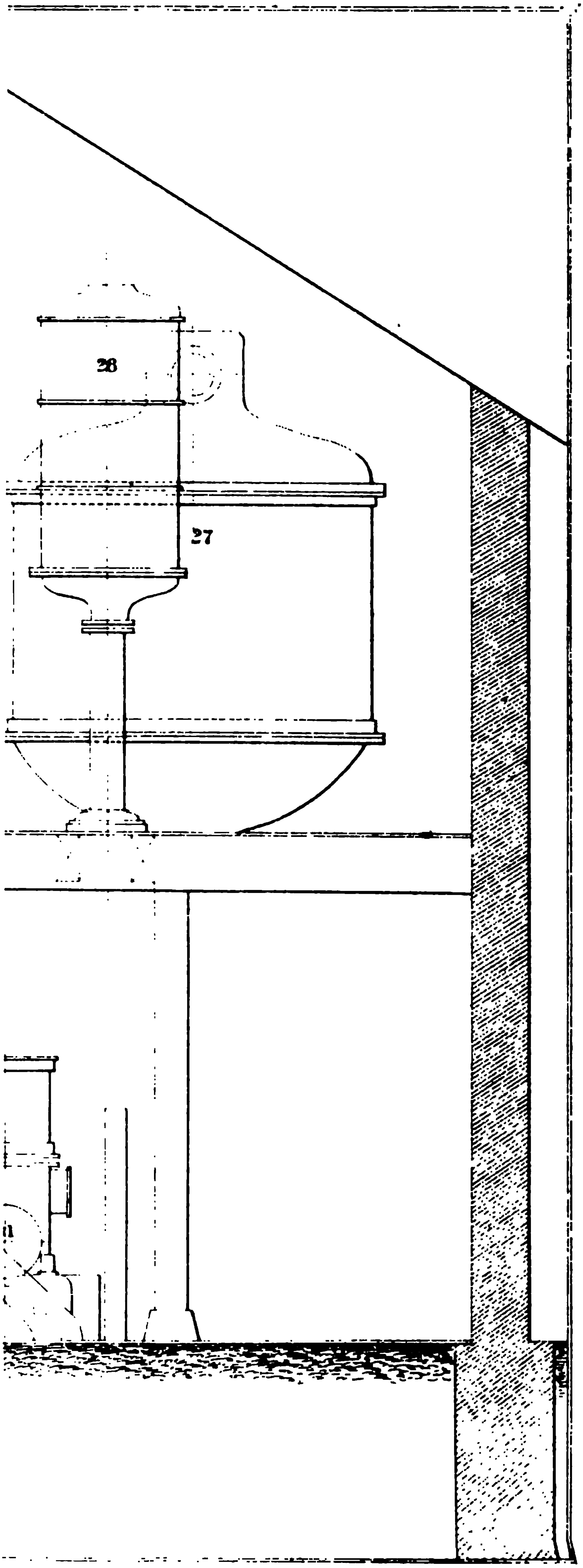


PLATE III.



Lith. of J. Bien, N.Y.

PLATE V



Lith. of J. Bien, N.Y.

PARIS UNIVERSAL EXPOSITION, 1867.

)RTS OF THE UNITED STATES COMMISSIONERS.

REPORT

ON

THE MANUFACTURE

OF

ESSED OR AGGLOMERATED COAL,

BY

HENRY F. Q. D'ALIGNY,

UNITED STATES COMMISSIONER.

WASHINGTON:
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1869.

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REPORT.

PRESSED OR AGGLOMERATED COAL.

ꟼORTANCE OF THE MANUFACTURE OF PRESSED COAL—ITS ADVANTAGES—MATERIALS :SED IN THE MANUFACTURE—QUANTITY OF ASH—MACHINES FOR WASHING COAL—PREPARATION OF THE PASTE—MACHINES FOR MAKING THE PRESSED-COAL BRICKS—FOUR DIFFERENT TYPES OF MACHINES DESCRIBED—IMPORTANCE OF THE PRESSED-COAL TRADE IN FRANCE, AND COST OF THE MANUFACTURE—SUGGESTIONS FOR THE MANUFACTURE OF PRESSED COAL FROM ANTHRACITE WASTE—QUANTITY OF COAL WASTE AT THE ANTHRACITE MINES OF PENNSYLVANIA.

INTRODUCTION.

The extremely important manufacture of pressed coal out of coal-ust and waste was not fully represented at the Exposition.

The manufacture has been developed chiefly by Belgium, France, ireat Britain and Prussia, but France alone made an exhibition of the nachines employed in its manufacture.

Before describing the machines which were working at the Exhi-ition, and a few others of practical importance, the manufacture of ressed coal will be briefly noticed.

It is only about ten years since this manufacture assumed any impor-ance, but during that period it has rapidly extended in Belgium and 'rance, and it is destined to become of much greater importance in the uture. Compressed coal is also prepared in England, but almost xclusively for exportation.

For a long time the fine and dust coal, the "slack" or "waste" of ollieries, had no practical value, and it accumulated to such an extent as o be an encumbrance, and to hinder the work of extraction and deliv-ry. Now, all this material is turned to profit by compressing it into ricks or cakes of a size convenient for burning.

Some of the advantages attending the use of pressed coal may be ited. Its purity and compactness adapts it to the rapid production of team in furnaces with small fire-grates, and it is therefore a desirable iel for steamers and locomotives, for which it is largely used.

Being manufactured in prismatic forms it can be very compactly stowed n ship-board or elsewhere.

It can readily be transported to great distances with very little waste, nounting, it is stated, to less than one-tenth the wastage of ordinary al handled under similar circumstances. It is not injured by frost or in.

Bricks of pressed coal produce as much steam in locomotives as an ual weight of coke. It is much liked by the firemen, especially for ising the steam in ascending heavy grades.

MATERIALS USED IN THE MANUFACTURE.

CEMENTS.

Pressed coal is made of coal dust and some cementing or agglutinating material which causes the particles of coal to adhere after a great pressure so as to form one solid mass. The materials which are suitable for the cement are not numerous. A good cement must possess the following qualities: It must be free from incombustible matter so that the quantity of ashes will not be increased; it must cause the particles to adhere strongly; and it must be cheap. Many materials, such as clay, damaged flour, lichen and tar, have been tried experimentally, but so far the pitch manufactured from coal tar has alone been successfully used. It is used as "dry" or "short pitch," and as "fat" or "heavy pitch." Tar does not answer the purpose. It mixes well with the coal, and the mixture is easily formed into bricks, but they do not stand the fire well; they melt, crumble, clog the fire-grates and give off quantities of smoke. The pitch which is used may be regarded as tar which has been concentrated by heat and has thus lost all its heavy and light oils.

Fat pitch may be regarded as a coal tar from which 25 per cent. of volatile matter has been expelled, and *dry pitch* as the same after the expulsion of 40 per cent. The fatter and richer the tar or pitch is in volatile matters, the more liable the coal bricks are to soften and smoke in burning.

The engine invented by Evrard, exhibited in the French section, is the only one which is used in the preparation of bricks with fat pitch. Dry pitch bricks are generally used. They are used in the navy to the exclusion of the fat pitch bricks, but some of the railways use the latter.

It is requisite that the pitch should be heated and softened as much as possible in order to be thoroughly commingled with the coal. It is therefore more difficult and expensive to make coal bricks with dry than with fat pitch; but, as has been shown, the value of dry pitch bricks is greater.

COALS AND THEIR PREPARATION.

Soft bituminous coals or the mixtures in which they predominate are generally used in the manufacture of pressed coal. These soft coals can be more easily moulded, and they furnish a greater amount of fine dirt, which can be had for very little at the mouths of the mines. Smith's coal does not furnish much fine or dirt at the mines; besides the fine can be used alone on the grates, where it agglutinates itself and makes good coke.

The anthracite coals are also appropriate for being agglomerated. The pressed coal bricks made from them are very solid, can be easily moved, but do not stand the fire so well. They burn well, but slowly, and remain

ood shape on the hearth if they are not stirred up; but if it is neces· to have a bright fire, and if it is frequently stirred, the poker breaks n the pressed coal bricks and causes them to fall into dust.

ifferent mixtures of glance coal and anthracite have, nevertheless, ı tried in France with satisfactory results, superior to those obtained he combustion of different coals not agglutinated together. This be easily understood, for in these mixtures bituminous coal fur- es the agglutinating material, and anthracite, so rich in carbon, gives eater heat. The use of anthracite coal dust for bricks will be subse- ıtly considered.

ressed-coal bricks are very easily manufactured, but precautions necessary to secure all the requisite qualities.

he best pressed coal must have the following qualities: It must be l, sonorous, homogeneous, and indifferent to hygrometric variations; lensity must be 1.20, and it must contain very little ash.

he French navy requires all these conditions for the pressed coal it ı. An allowance of 1.19 instead of 1.20 is, however, tolerated in the sity. The navy requires, also, that the pressed-coal bricks shall not en after having been heated for 24 hours in an oven at the tempera- of 60° C. This condition, which is a special one for the navy, is lered necessary in consequence of the high temperature of the coal kers, which are generally located near the boilers. If the coal bricks e to soften, the entire shipment of coal would stick together and form mass. Dry pitch is, therefore, exclusively employed for manufac- ng pressed coal intended for the navy.

ı regard to the quantity of ash the navy department is not as strict he railroad companies. The limit of percentage of ash allowed by navy department in the pressed coal is 10; and the following per- tage is tolerated by the following railroad companies:

thern Railroad Company			7.5	per	cent.
ns	"	"	7	"	"
ans	"	"	7	"	"
thern	"	"	6.5	"	"

he Orléans Railroad Company, however, accepts the pressed-coal ks even when the ash exceeds seven per cent., but in this case the pany reduces the price in proportion to every one per cent., or frac- of one per cent. of ash.

he importance of an accurate knowledge of the quantity of carbon volatile matter in different varieties of coal, and of determining ırately the quality of pressed-coal bricks, has led most of the railroad panies to establish chemical laboratories of their own, where accurate yses are made.

ıe determination of the quantity of ash and other incombustible mat- existing in coal, is also very important to private consumers. It is often preferable to pay much more for a better and purer coal, tha n

to have an inferior article at a low price, especially when the cost of transportation is great.

The coal of some mines has not the qualities requisite for perfect agglomeration. If it is used alone the bricks are inferior in quality, and will not bear transportation to a distance. In such cases the bricks are generally made of small size, adapted to domestic purposes, and are sold for use near the place of manufacture. Ordinarily, however, these inferior coals are mixed with the dust of the better pit coals, and pressed into bricks, which can be sent great distances without injury, and can be profitably used for all industrial purposes.

Whatever may be the quality of coals, if they are intended for the use of railroad companies and metallurgical establishments, it is necessary to reduce the quantity of ash as much as possible, and, therefore, it is necessary to wash the combustible material with the greatest care.

This is every day becoming a more important matter. The close competition among the manufacturers of pressed coal leads them to constantly study to obtain the best processes for washing, and the best automatic machines to perform this work.

MACHINES FOR WASHING COAL.

The fragments of slate found with coal being nearly all flat, are difficult to separate from the coal by washing. They present too great a surface to the current of the water, and are often carried off with the coal in the operation of washing.

Messrs. Huet & Geyler exhibited a machine for washing coal constructed like their automatic jig, and represented by a figure on the Plate.

This machine appears to be well calculated to give satisfactory results. It is constructed of iron. The piston has a rapid downward motion so as to lift up the stuff on the grate. Its motion is then momentarily arrested, which allows the stuff in settling to separate according to the gravity; and, finally, the piston rises with a gradual and slow motion favorable to a separation of the materials. When the stuff is well separated the pure coal forms a stratum on the surface. The slate and heavy pieces accumulate on the grates; the coal is then carried away by the automatic scraper *s* which moves back and forth.

The slate rock, which accumulates on the lower part of the inclined grate, escapes through a waste valve V, and is carried by an inclined pipe to an archimedean screw A, which elevates and discharges it by the chute B.

The slimy matters falling through the grate gather at the bottom of the sieve, and run away through a valve C, which is opened from time to time. This apparatus will wash from 75 to 150 tons of stuff per day, according to the coal, and to the degree of purity which is required.

The process of washing and cleaning naturally saturates the coal with water, and though a certain dampness is not objectionable in the manufacture of pressed coal, yet all excess of water must be removed before

the coal is pressed and ready for combustion. This is accomplished by means of centrifugal mills, similar to those used in sugar refineries to accomplish the same result.

After this operation the coal does not retain more than five or six per cent. of water, which is quite useful in the operation of moulding into coal bricks.

COAL-DRYING MACHINES.

The machines for drying coal are usually rotary. A revolving disk, making from 1,000 to 1,200 revolutions per minute, receives the baskets-full of coal. The water is thrown off by centrifugal force through the holes of the baskets.

Mr. Heinrez, of the Belgian section, exhibited a drying machine represented by Fig. 2, Plate I. This machine is an ordinary turbine, having instead of the bottom a helix which revolves much slower than the outer part of the turbine. The coal is fed at the top of the helix, and descends gradually to replace that already dried by the rotary motion of the turbine.

We do not know from observation what the practical results of this ingenious contrivance are, but Mr. Heinrez claims that it will dry five tons of coal per hour.

Coal, from its nature, is very hard to agglomerate. To obtain a paste which is solid, strong and homogeneous, the coal must be broken very fine. It is therefore always necessary to crush it, and this is done either by means of the edge stone mill or by rollers, or any other machines which can crush fast and fine.

PREPARATION OF THE PITCH.

We have already observed that the pitch is made from coal tar deprived of its volatile oils by heat. The heavy pitch is the result of the first distillation; the dry pitch is the residue left after the entire distillation of the oils. The pitch is not usually prepared by the manufacturers of pressed coal, but is bought ready-made from establishments for the distillation of coal oil.

Heavy pitch does not require any special treatment before being mixed with coal. Dry pitch, on the contrary, must be first ground like pit coal, and even finer, not only in view of making better pressed coal, but especially to economize the pitch, which is quite expensive.

The proportion of pitch in agglomerated coal varies from seven to eleven per cent. of the whole paste, according to the nature of the coal, and the care with which the compound is mixed. It is generally understood that a large quantity of pitch is required for coals which are very rich in carbon, and also for coals containing considerable volatile matters, and which do not agglutinate.

WORKING THE PASTE.

When the materials are ready, the paste is made in the followi manner: coal tar alone, when cold, is liquid enough to mix with coal, b pitch, either heavy or dry, must be softened by heat so as to stick the coal when pressed. Before mixing, the coal must be heated to 1 or 120 degrees centigrade, otherwise the particles would stick togeth and form one mass as soon as they are brought in contact with t pitch. In heating the coal, steam is generally made use of, which applied directly to the coal if it is not already too damp, otherwise it conducted in pipes through the mass to be heated. The heavy pitch well melted in a boiler, and then poured over the coal. The materi are strongly mixed in a kneading or mixing apparatus, heated by stea called a *malaxator*, which converts them into a paste the temperatur which is from 30 to 35 degrees centigrade. The paste is then pas through the press. Dry pitch melts at from 120 degrees to 125 degr centigrade, and can be mixed with coal in two ways. Sometimes t coal and pitch are mixed in certain proportions after having been grou separately. In other cases they are ground separately, then mixed a ground together again. A kneader heated by steam, or, better, by sup heated steam, is used to form the paste, which is pressed in the us way. The temperature of the coal at this stage of the process is abo 70 degrees centigrade.

MACHINES FOR MAKING PRESSED-COAL BRICKS.

There are many machines for making pressed coal, but a few only a practically used. There may be said to be five different types, accor ing to the different manner of pressing the coal.

These different types may be enumerated as follows:

1. Machines in which the pressure is obtained by the hydraulic pre
2. Pressure by the direct action of steam.
3. Machines with open moulds.
4. Machines in which the coal is pressed between rollers.
5. Other machines not included in the four preceding types of co struction.

As a general thing in all these machines the mould is of a prism form, with either a square, rectangular, polygonal, or circular base. T paste is pressed by a piston fitting the mould. In some machines t end of the mould is closed while the piston works; in others it rema open.

MACHINES IN WHICH THE PRESSURE IS GIVEN BY THE HYDRAULIC PRE

The general construction of machines of this type is as follows: mould is placed opposite the piston of an hydraulic press; the pist rises gradually and presses the paste steadily until the pressure is eq to the number of atmospheres necessary to produce the agglomerati As the course of the piston of the hydraulic press is not limited, all

ıkes of agglomerated coal must be subjected to the same amount of 'essure even if the moulds are not filled with the same quantity of aterial. The bricks or cakes, though of different thicknesses will have e advantage of being all manufactured under the same pressure.

It is necessary also to submit the cakes to the maximum pressure for me time, otherwise the outside parts alone of the cakes are well pressed iile the interior remains soft. The best machines of this type are erefore arranged so as to obtain this result. It is evident that the ıchines in which the paste is subjected for a short time to a high pressure must produce less in a given time than the machines in which the ste is subjected to a powerful but instantaneous action. This inconnience has been avoided in the most recent hydraulic presses, which e made to press a number of cakes in the same operation. With these ıchines the advantages of the hydraulic press are somewhat lessened, l the moulds will be under the same pressure; but as it is impossible ways to have an equal amount of paste in each mould, the pressure one mould against another is not likely to be even. To obviate this convenience, an enormous pressure is given to all the cakes, so even some receive less pressure than others yet all receive enough. A orkman is specially employed to watch and see that the moulds are 'enly filled up.

RÉVOLLIER'S PRESS MACHINE.

As a specimen of hydraulic engines, we refer to Mr. Révollier's press. ts construction has been described by Professor A. Burat in his work *Matériel des Houillères,*" where much interesting and valuable information will be found on the subject of agglomerated coal. Révollier's achine consists of a *mixer*, a *feeder*, and a *press*. Figs. 3 and 4, Plate I. The press is made of a strong circular plate containing at equal disınces four series of 21 moulds each. This plate makes one-quarter of revolution at a time. Every time it stops a series of moulds comes ıder the feeder and is filled. The second series of moulds is then ıcovered, an attendant examining it carefully to see that the paste is ıually distributed in the moulds. The third series is at the same time ıbjected to hydraulic pressure, and lastly, in the last series of moulds e bricks are pressed out by a second hydraulic press. Twenty-five to irty revolutions of the moulds can be made in each hour, and the 'erage production is five tons of pressed-coal cakes per hour. The ıtive power required is equal to about twenty-five horses, and the essure transmitted by the hydraulic press is 830 tons.

SECOND TYPE—MACHINES WITH STEAM PRESSURE.

In this engine the steam acts directly—the piston which presses the ıl being directly connected with that of the steam-engine. The ion is instantaneous, and the intensity of pressure depends upon the ce of the steam. The direct action of steam is quicker than that of

the hydraulic press, and more work is done in a given time, but it is not as perfect, and the condensation throughout the mass of paste is not uniform.

MAZELINE COAL-PRESSING MACHINE.

In this engine the pressure is transmitted directly to the coal by th piston of the steam-engine. Its construction is fully described in th 14th volume of M. Armengaud's "*Publication Industrielle*," but it h been somewhat altered and improved since that time. The follow information has been furnished by Mr. Mazeline, the exhibitor. H apparatus includes a mixer, a feeder, and a press, all acting togeth and working under the same gearing. See Plate I, Figs. 8 and 9.

The kneader or mixing cylinder is capacious, and made of sheet ir It is entirely open at the top, and closed at the bottom by a circu piece of cast iron, which acts as a bottom or support to the cylind Two apertures or lateral canals are made in the sides for the escap the paste. The cylinder is transversed from the top to the bottom b vertical shaft, which turns independently, and is armed with cams blades when the shaft is set in motion. When the paste arrives in cylinder it is heated by currents of steam, which are thrown on the pa through openings made at the bottom of the mixing cylinder. Th steam pipes are supplied with cocks, so that the supply of steam can regulated. The bottom of the mixing cylinder is conical, and the low arms of the vertical shaft are helical. They drag the paste from t bottom and squeeze it through the lateral openings. Sheet iron damp open or close these lateral openings, and regulate the amount of pa passing through them.

The press consists of a strong cast-iron plate or disk, bearing on i circumference ten rectangular moulds, which are lined with brass so th they can be removed and changed when worn out. This plate revolv on a vertical axis, and turns only enough at each movement to bri each mould in succession under the feeder. Two moulds are filled once, and each mould passes twice under so as to receive a thorough an uniform filling. The piston-rod of the steam-engine is connected directly with the die, which presses on the paste in the mould with a force equa to that of the steam on the surface of the piston. Another contrivan acts simultaneously with the die, and pushes the cake in an opposit direction out of the mould. The total pressure on the paste given i this machine is sixty-three tons, which is sufficient to give to the coal the desired agglomeration.

THIRD TYPE—MACHINES WITH OPEN MOULDS.

In these machines the moulds are left open, and the piston presses the paste through them. The maximum pressure of the cakes is equal only to the friction of the sticky paste in passing through the mould. I

ight seem that very long tubes would be necessary to obtain good akes; but a tube of a few decimetres in length is enough to give to the akes the required solidity and compactness.

EVRARD PRESSED-COAL MACHINE.

To illustrate the third type of agglomerating machines we mention hat of M. Evrard, which is extensively used at the mines of Chaotte. A beautifully finished model of this machine was displayed at he Exposition. It has 16 cylindrical moulds, disposed radially, in rhich the coal paste is pressed into bricks by pistons actuated by an ccentric. Its construction is indicated by Figs. 5 and 6, Plate I. To his engine a gold medal has been awarded. It is fully described in the ourth volume of the "*Bulletin de la Société Minérale.*" M. Evrard uses he heavy pitch. The coal and pitch are heated separately, and then nixed together. The paste passes through a cylinder containing a helix efore coming into the *malaxator* or mixing cylinder, which is similar to hat described above. The paste is conveyed by pipes from the mixing ylinder to the press, which consists of a thick cast-iron tube or mould laced horizontally, and open at both ends. At the upper part of this ube is a feeder which continually supplies the paste. The piston is riven forward and backward in the tube by an eccentric; the backward novement withdrawing the piston beyond the feeder, which at the same ime discharges into the mould the required quantity of paste; the forrard movement giving to it the requisite pressure. At each alternate orward movement of the piston a certain amount of paste is compressed nd pushed ahead. Practice has shown that the resistance caused by he great friction of the paste on the interior of the short tube is equal to he pressure required to agglomerate the coal. The cakes delivered by his machine are of no definite length, but are broken across to the equired size. This machine is, in fact, quite similar to certain machines sed in the manufacture of bricks.

The complete apparatus has 16 cylinders, and is driven by a 50 horseower engine. It makes from 90 to 100 tons of agglomerated coal daily. ne overseer, two men, and four boys are all that are required to tend it.

The composition of the coal from the "Chazotte" mine is as follows:

arbon, per cent	81.00
olatile matters, per cent	16.50
Ash, per cent	2.50
	100.00

From seven to eight per cent. of heavy pitch is used; less than eight er cent. of water does no harm to the agglomeration.

FOURTH TYPE—ROLLER MACHINES.

These machines work the paste between two rollers, which have oulds cut in one or both of them. The best machines of this style have

till now produced only small cakes requiring but little pressure, good enough for home consumption but unfit for transportation.

This type of machines is described by Mr. Grüner in the sixth volume of the sixth series of the "*Annales des Mines*."

The David machine, which resembles the Joseph Grant brick making machine, consists of two tangential vertical cylinders or wheels armed with moulds and teeth, the teeth of one fitting into the moulds of the other. An eccentric forms the bottom of the mould, which, when the paste has been compressed by the tooth of the other wheel, pushes the cake out of the mould. The pressure obtained by these machines is not enough to manufacture solid agglomerated coal. The cakes are small and poorly shaped.

This class of machines can manufacture from 30 to 35 tons per day.

Jarlot's pressed-coal machine, Fig. 7, Plate I, is fully described and illustrated by drawings in the twenty-third volume of the "*Génie Industriel*." It is similar to that of the David machine; the bottom of the mould is, however, open instead of being closed by an eccentric, the moulds themselves being a little narrower towards the centre of the wheel than at the circumference. The paste which has been compressed by the teeth of the other wheel escapes through the smaller end of the mould, and makes a continuous cake, which is cut off by a knife specially adapted to this purpose.

With a 25 or 30 horse-power machine, four or five tons of pressed coal cakes can be manufactured per hour. This machine is represented on the plate Fig. 7.

It has already been mentioned that the inconvenience which attends machines of this kind is that the amount of pressure, which depends on the amount of paste deposited in the mould, can never be determined. With the hydraulic press, on the contrary, the piston follows up the paste until the required pressure is obtained; the cakes are therefore pressed with the greatest regularity.

The fifth class includes a variety of machines for moulding pressed coal which do not belong to either of the preceding types, but most of which are yet unknown in practice.

All the machines for pressing coal which are really of practical value, such as that of Mr. Detombay and some others, are, aside from a few modifications, similar to one or the other of the three first styles of machines we have described.

All desirable information concerning pressed-coal machines and the manufacture of agglomerated coal may be found in the following works: Prof. A. Burat, "*Portefeuille du matériel des houillères;*" Mr. Grüner, "*Annales des mines,*" vol. vi, series 6; "*Revue de Liége,*" vol. x for the year 1861; "*Annales des travaux publics en Belgique,*" vol. xix for the year 1860; "*Bulletin de la société minérale,*" Mr. Evrard, vol. iv; "*Bulletin de la société minérale,*" Mr. Jordan, vol. v; "*Bulletin de la société*

minérale," Mr. Geraudeau, vol. v; Mr. Armengaud, "*Machines, outils et appareils,"* vols. ix, xiii, xiv; Mr. Armengaud, "*Génie industriel,"* vols. vi, xiii, xiv, xxii; Mr. Hecker, "*Bergwerksfreund,"* new series, vol. i.

IMPORTANCE OF THE PRESSED COAL TRADE IN FRANCE.

The pressed coal trade has of late years increased considerably in France. In 1863 it amounted to 400,000 tons, and during the year 1867 the consumption was over 900,000 tons, which can be distributed as follows:

Railroad companies	731,600 tons.
Navy	150,000 tons.
Other industries	70,000 tons.
	951,600 tons.

The amount consumed by "other industries" must be considered as a minimum, as there is now a general tendency to open a wider field for the use of this valuable fuel.

Among the railroad companies, that of Lyons—"Paris, Lyons, Mediterranée"—consumes pressed coal exclusively. This company requires about 1,200 tons per day, or nearly 400,000 tons per annum. The company pays 22 francs a ton for the pressed coal delivered at the Lyons depot. The pressed coal used there is manufactured in the neighborhood of St. Etienne, about twenty miles distant. The Northern Railroad Company—"Paris, Amiens, Dunkerque, Calais"—does not use pressed coal exclusively, although its daily consumption amounts to 300 tons, or about 120,000 tons per annum.

COST OF PRESSED COAL.

The net cost of pressed coal, including the motive power, the wear and tear of machinery, and the labor, for different French and Belgian districts, varies from 1 franc 80 centimes to 2 francs 20 centimes per ton. The price of pitch is from 50 to 60 francs per ton. The waste of pitch in the principal manufacturing establishments is from 7 to 10 per cent. The average may be considered to be 9 per cent. In the most important manufacturing centres the net cost per ton of pressed coal averages from 6 francs 50 centimes to 7 francs 50 centimes. During the past year, however, pressed coal was sold at the mill for 20 francs per ton. The fine dirt coal, which formerly was almost worthless, has thus paid a profit of from 12 francs 50 centimes to 13 francs 50 centimes per ton. We believe that this branch of business will greatly increase. If the paste were more carefully manufactured it is probable that the proportion of pitch could be reduced one or two per cent., which would greatly reduce the net cost of the manufactured product.

Since 1865 the price of pressed coal has greatly increased, for two reasons:

1. Because the advantages of this new kind of fuel have become more widely known, and the demand greater.

2. Because the modes of manufacture and the qualities of this new fuel have been greatly improved.

In 1865 pressed coal was worth from 17 to 18 francs per ton; in 1866 pressed coal was worth from 20 to 21 francs per ton; in 1867 pressed coal was worth from 22 francs to 22 francs 20 centimes per ton.

Pressed coal containing from 16 to 20 per cent. of volatile matter is preferred by consumers. The railroad companies, when making contracts for this fuel, allow six per cent. of ash, and tolerate a difference of one half of one per cent. more or less than the standard allowance, with, however, a corresponding difference in price, which is an increase of one franc per ton for every one per cent. less than the standard, and a decrease of one franc for every one per cent. more than the standard. When the amount of ash exceeds eight per cent., the coal is rejected.

All the railroad companies and the navy must soon acknowledge the great advantages derived from the use of pressed-coal fuel. It contains the greatest amount of carbon in the smallest given space, while the quantity of ash determines the price, whereas with ordinary coal used in lumps the proportion of ash is always variable.

Pressed coal is invaluable for steamers for transatlantic or coasting navigation. A cargo of pressed coal will represent almost mathematically a solid mass of coal; the coal bunkers of a ship therefore, will contain 50 per cent. more of this material than of ordinary loose coal in lumps.

Taking 400,000 tons as the average amount of pressed coal annually consumed by the Paris, Lyons, Mediterranée railroad, and assuming that the consumption of each of the other railroad companies will be the same, the total demand for pressed coal for French railroads will become 2,500,000 tons annually; the navy will require about the same amount, so that in a few years the demand in France alone will reach 5,000,000 tons per annum, worth $22,000,000.

SUGGESTIONS FOR THE MANUFACTURE OF PRESSED COAL FROM ANTHRACITE WASTE.

It has already been observed that anthracite coal dust or slack can be agglomerated like all other coals, and that the cakes obtained from it bear transportation, the main difficulty being to make them stand the fire without crumbling.

One of the following methods might be tried for agglomerating the anthracite alone:

First, follow the ordinary process, but grind, mix, and blend the coal and pitch with the greatest care, so that the powders are fine, evenly mixed, and in definite proportions. Practical men believe that kneading and mixing machines do not correspond in excellence to those used for pressing the coal, which are comparatively perfect. If mixing

machines were more thorough in their action the quantity of pitch employed—which is the costly ingredient and keeps pressed coal at the present high rates—might be lessened. However, with anthracite, even when the paste is made as homogeneous, as thin, and as well worked as possible, it will be necessary to submit it to a greater pressure than the paste of ordinary coal requires, and to maintain this pressure for a longer time.

The second method for the agglomeration of anthracite which could be tried, consists in the process used for manufacturing what is called "*Charbon de Paris.*" The paste made of it with coal tar, with all possible care and strongly pressed, might be heated in an oven to 300° centigrade until all the oils are entirely volatilized.

The third method is one which has already been tried with success by Mr. Bayle. It consists in making a paste of fine coal dust and coal tar, exposing it to a strong fire until, by distillation, the tar is altered into pitch in the paste.

The collieries of France are located on the eastern frontiers and can advantageously supply only the northern, eastern, and southern railroads. On the other hand, the western, southeastern, and central railroads find considerable difficulty in procuring coal from the French collieries either by canals or overland. Philadelphia is in direct communication with the western coast of France, and is also in close proximity to the great anthracite and bituminous coal fields of Pennsylvania. There is no reason why this city should not become the great market which would supply the western coast of France, with compressed coal. Shipments could be made with equal facility to Havre, Brest, Nantes, or Bordeaux, from all of which ports the pressed fuel could be distributed to the interior of the country. The immense heaps of coal now lying around the collieries in Pennsylvania, and which are at present not only worthless but an incumbrance, should become a source of wealth, and should be the means of creating at home an important and profitable industry.

The following extract from the work published on oil, coal, and iron, by Messrs. S. H. Daddow and Benjamin Bannan, is appropriate here. It shows the importance of compressed coal and the results that may be derived from the practical introduction of this manufacture in the coal producing States:

COAL WASTE AT THE ANTHRACITE MINES OF PENNSYLVANIA.

If we take fifteen per cent. as the average waste of our mines in dust or efuse coal, (and this is a low estimate,) we find that we sustain a loss of ne and a half million on a business of 10,000,000 tons per annum. This mmense amount of waste is constantly being piled up around our mines vast, unsightly mounds, burying our mining villages, and sadly ncroaching on the limits of our chief towns. Those who are familiar

with St. Clair will remember the mountains of coal dirt which alm encircled and which encroach even on its streets.

The amount of this waste that now lies around our coal mines can be short of 15,000,000 tons, and each year adds to the rapidly accu lating dirt bank, though every flood of rain carries off a portion to c cellars, streets, canals and rivers. It will become a necessity in ti to find some mode of disposing of it.

There can be no doubt that it can be made use of, and perhaps wi much profit and advantage, if capital and enterprise could be divert from the coal mines to the coal banks. The amount of money requi to put up a first-class colliery, capable of mining and shipping 500 t per day, would erect machinery powerful enough to compress e anthracite coal dust to a state almost as solid as when it existed in bed beneath the mountains; and perhaps the amount so consolid per day would not be less than could be obtained from the mi Anthracite coal dust can be solidified by pressure without the admix of any foreign ingredient; but the pressure must be powerful. admixture of ten per cent. of wet peat, or of five per cent. of fine clay, help the solidification, and make the blocks more tenacious and dura The amount of ash or residue would not be greater than that left the consumption of ordinary coal, since the combustion is more perf and no cinders or unburnt embers are left.

But when circumstances will admit, an admixture of fifty per c of the rich bituminous coals will make a better fuel, and require other adhesive substance than the bitumen which the bituminous c contains, which is brought into an oily state by heat. By mixing h and half of the anthracite dust with fine or pulverized bituminous co and pressing them with great power in a hot state, the solidification w be complete. But the pressure required is much greater than m readily be imagined by those who have not tried the experiment. T writer instituted a series of such experiments at considerable cost time and money, some years ago, and speaks from practical operatio Perhaps the best place to establish such a business would be near so large city, where either clay or bituminous coal can be had more read than around the anthracite mines, and the anthracite dust can be tra ported cheaper in that condition than when formed in blocks ready fuel.

Coal tar and coal oil have been proposed, and the former is us extensively in Europe to produce composition fuel. Coal tar is certai as good as bituminous coal, but we do not think it could be obtained sufficient quantities and at a cost to justify its use for such a purpose

Bituminous coal is always accessible at reasonable cost, and the fi coal can always be had for considerably less than the lump coal—enou so, in fact, to pay for the operation of compressing. The Richmo (Virginia) coal is the most available for such a purpose, on account its fat and bituminous character, and may be mined and brought

Philadelphia cheaper than the coal from our anthracite mines, by the same outlay and enterprise displayed by the anthracite miners, since the coal is only fifteen miles, on an average, from tide-water on the James, or not more than the average distance of our anthracite mines from the head of navigation on the Schuylkill or Lehigh, or the head of the leading railroad lines, to Philadelphia.

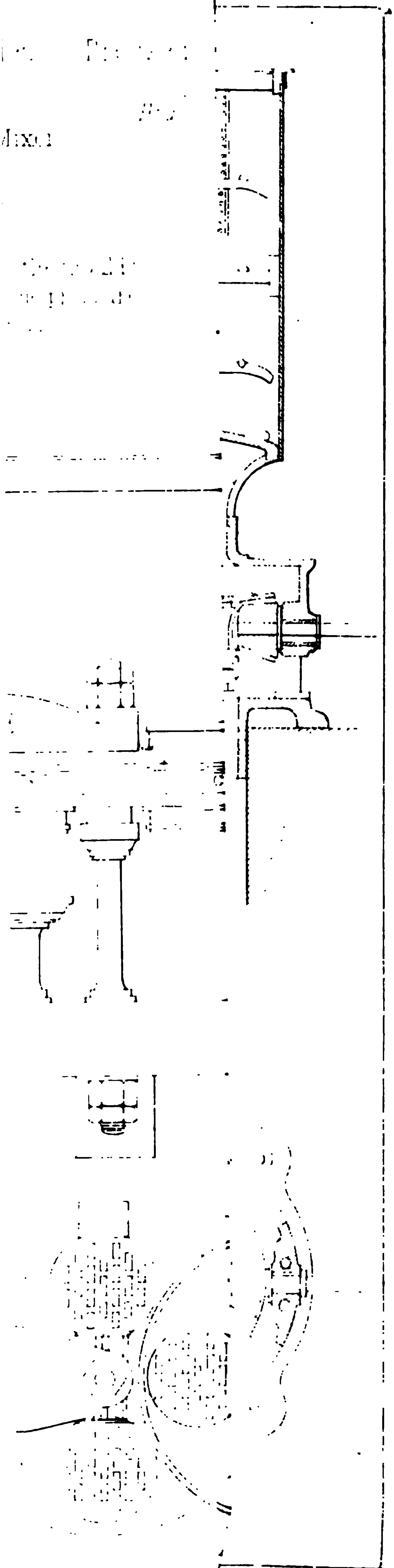
We have no doubt of the feasibility of the plan here suggested as a means of converting our immense heaps of waste into an excellent article of fuel, with much profit to those who might engage in it, provided they put capital enough in to insure success. Such a "mutual coal-consumers' company" would stand better chances of their winter's fuel, and of reasonable profits, than many which have been blindly and foolishly gone into by the coal-consumers of the eastern cities.

Respectfully submitted by,

HENRY F. Q. D'ALIGNY,
United States Commissioner.

NEW YORK, *June*, 1869.

PLATE I.



Bien Lith N Y

PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

PHOTOGRAPHS

AND

PHOTOGRAPHIC APPARATUS,

BY

HENRY F. Q. D'ALIGNY,

UNITED STATES COMMISSIONER.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1869.

CONTENTS.

PHOTOGRAPHY.

OTOGRAPHS AND PHOTOGRAPHIC APPARATUS.

.CHARACTER AND EXTENT OF THE EXHIBITION.

ı the following brief report upon Class 9, "Photographs and photo-phic apparatus," it is designed to notice only those features which are el or that show well-marked improvements in processes, appliances, or aratus. It is hoped that in this way, without entering into descrip-.s and details well known to every photographer, the report may be le of some service to those who are acquainted with the art.

.s a whole the exhibition of photographs was the best that ever has n made, and it gave satisfactory evidence of progress in the art in all lepartments and in all countries. There were over 650 exhibitors. nce had 183, Great Britain 105, British colonies 41, Austria 58, ssia 52, Italy 43, Russia 14, United States 10, Spain 10, Switzerland, ımark and Belgium each 11, Brazil 7, Greece 5, Sweden 7, Norway 6, land and Bavaria each 4, and other countries, including Algeria and 'key, only one or two.

.s it is impossible to fully notice or to describe this vast display, only a of the most important and notable features will be mentioned.

FRANCE.

n the French section the productions of Salomon, Duvette, and Braun ıand more than a passing mention. For portraits, Adam Salomon ; be said to stand foremost. He was among the first, if not the first,) has succeeded in producing really artistic pictures. In the artistic e of the sitter, the arrangement of light and shade, and in the tone . color, his pictures are unrivalled.

'he panoramic views by A. Braun, of Dornach, Haut-Rhin, and Rue let, in Paris, were equally remarkable for excellence and for choice subjects. Among the objects represented were Alpine scenery, par-ılarly the glaciers; reproductions of the plans and drawings of the ıvre, and of the Museum of Bâle. His panoramic views on a large le, thirty inches long and twelve inches wide, and embracing all hin an angle of one hundred and twenty degrees, are unequalled; omplete pictures from one negative having before been obtained of r eighty degrees except in very small proofs.

'uvette's exhibit may be noticed chiefly for his enlarged pictures of cathedral at Amiens. These were eight feet in length, and the lines e not distorted, but were quite straight and sharp.

In a historical point of view the exhibition by Niepce de St. Victor, of Paris, was extremely interesting. He displayed a specimen of heliographic engraving by Nicephore Niepce, obtained in 1824 upon a plate of tin; the first negative upon glass obtained in 1848 by Niepce de St. Victor, and the first positive impression taken from it; albumenized paper made in 1850; the first proof of heliographic engraving upon steel, made by the process of Nicephore Niepce, modified by Niepce de St. Victor. The collection also contained specimens of engraving upon marble, and pictures obtained with the salts of uranium in 1859.

Pinel-Peschardière exhibited examples of photographic engraving upon metals, and upon lithographic stone; photographic relief plates for printing and lithography, and specimens of colored photographs vitrified in ceramic enamels.

The enamels shown by Lafon de Carnarsac were remarkably perfect.

Some of the best examples of photographic engraving were seen in the proofs by M. Drivet, which from their actual resemblance to the work of the engraver were scarcely noticed as photographic productions.

Jean Renaud exhibited some fine landscapes taken by the tannin process.

ENGLAND.

In the English department we may notice favorably the always beautiful landscapes of Bedford, the sky studies of Colonel Stuart Wortley, and the admirable dry-plate pictures of Mudd. The portraits were commonplace.

The process of Mr. Woodbury—printing in colored gelatine from a metal mold taken by hydraulic pressure from hardened gelatine—was well represented by some small specimens.

Specimens of carbon printing of surpassing beauty, by the process of Mr. Swan, of Newcastle-on-Tyne, were shown. The very best prints could not equal the fine effects of these pictures. Their permanency is also a great recommendation.

There was also a very interesting series of photographic views of the ancient architecture of India, as shown in the temples and palaces of the interior of that country.

RUSSIA, PRUSSIA, AUSTRIA, AND OTHER COUNTRIES.

From the Ottoman Empire there were some fine panoramic views of Constantinople, the work of Abdullah Brothers, and remarkable for their size and excellence in all respects.

From Italy, as might be expected, there were many photographic copies of the choicest paintings—there being upwards of eighty pictures representing the works of Raphael alone.

There was nothing remarkable in the exhibition of photographs from Russia and the northern nations.

urtemberg sent a picture by Brandseph, nearly six feet long, com-d of three pieces representing the royal palace.

'om Austria there was, as usual, a very fine show of photographs, among them the pictures by Louis Angerer were very prominent beautiful.

ıe condition of the photographic art in Prussia was well represented ıe veteran photographer, Professor H. Vogel, and by Schauer, of Ber- who had a fine reproduction of Menzel's painting of Frederick the ınd at a dinner party.

NORTH AND SOUTH AMERICA.

:om the United States, Canada, Brazil, and other parts of North and :h America, there were many views characteristic of the scenery of New World.

ıe most striking and attractive display from the United States was e by the photographers of California, and their pictures compared rably with any in the Exhibition, if indeed they were not fully equal ny.

r. C. E. Watkins, so well known as the photographic artist who has n to the world a series of views of the wonderful Yosemite Valley, alifornia, exhibited a complete set of these views of full size, and 's, also, of the grove of great trees near Mariposa.

essrs. Lawrence & Houseworth, of San Francisco, also exhibited y large photographic views of the Yosemite Valley, and numerous ographic pictures illustrating the scenery of California and Nevada the operations of placer mining.[1]

ıe astronomical photographs by Lewis M. Rutherfurd, esq., of New ː, were extremely interesting to photographers and men of science, attracted much attention. One of these photographs was of the n's surface, and another of the solar spectrum, showing the dark ı. Both are noticed at length under the head of applications of ography.

ıe display of photograph portraits from the United States, especially e of large size, was creditable in the highest degree.

ıving thus briefly mentioned some of the most remarkable exhibi- ı of photographs, some of the processes most worthy of note, and h are likely to increase in importance as they are developed by rience, will now be noticed.

IMPROVEMENTS IN THE ART OF PHOTOGRAPHY.

must be acknowledged that up to the present time the difficulties hotography as an art commence with the printing from the *cliché* or

[1] the close of the Exposition, these views were donated by the exhibitor to various c societies and institutions, including the Photographic Society of Paris, the Jar-es Plantes, the Geological Society of France, and the British Museum.

negative. The obstacles in the way of obtaining a perfect negative are not insurmountable, and the negative when once procured may be considered to be indestructible. But it is far otherwise with the finished photograph taken from the negative by the common silver printing. The limited experience of only twenty-five years, a mere fraction of the time a photograph should endure, has been sufficient to show the fleeting nature of photographic prints obtained by the use of silver, and if photographs are to be anything more than evanescent shadows other processes must replace silver printing. The marked advance in carbon printing, satisfactorily shown at the Exposition, indicates a new phase of the art, and the commencement of more durable records. Some details will now be given of the latest improvements in carbon printing by Mr. Swan, of Newcastle, the results of which are in every respect equal to the finest silver prints. The manipulation, though more complicated, will, when the working is well organized, actually require less labor than the silver printing, and the process is at least twice as rapid, and has another advantage—the entire command of color. The drawback is the difficulty of ascertaining the time of exposure, which can only be done by comparison of the action of light on some known standard of photogenic paper. In a large and well-organized establishment this latter difficulty can be surmounted in several ways, but when operating on a small scale it is more difficult to provide for.

MR. SWAN'S PROCESS.

The process is as follows: An endless band of ordinary paper about twenty feet long is prepared by pasting its two ends together. This is placed upon two rollers, one above the other, and ten feet apart, and provided with the means of adjustment for the proper tension upon the paper.

This band of paper is now put in motion by rotating the rollers; at the same time a warm bath of melted gelatine, with any desired pigment, carbon, or color, with or without a portion of glycerine added, is placed underneath the lower roller and in contact with the surface of the paper as it passes under the bottom roller. The revolving paper licks up the colored gelatine, rises up, passes over the upper roller, and descends again into the bath for another layer, the first layer having during its passage become partially set or solidified. By attention to the temperature of the bath, the speed of the rollers, and the temperature of the room, any desired thickness of coating may be given to the paper. By changing the vessel containing the pigment different layers of colored pigment may be placed on the tissue, as the paper thus prepared is called. The tissue when dry is ready for use, and it is rendered sensitive in the following manner: the required piece of paper is placed in a bath of bichromate of potash solution, formed by dissolving one part of the salt in ten parts of water. In about one or two minutes the tissue becomes

mp, but not sticky, and it is at once taken out and hung to dry in a ark place. It should be thoroughly dry in about eight or nine hours. slight dusting of French chalk is given to the tissue, and it is then laced in the printing frame, with the gelatine side next to the negative. he length of exposure must be tested by a piece of ordinary silver aper. The method employed is the following: a piece of the albu- nenized paper is printed to a certain shade of color, which is assumed s a standard and called a unit; the exposure required is given as xperience indicates to one or several units of light, and the amount nce known, successive prints may be taken from the same negative with erhaps more certainty than in silver printing.

An ingenious photometer, the invention of a Mr. Louis Bing, of Bish- p's Hortford, England, and patented in that country September 13, 1866, s also, we believe, employed by Mr. Swan. A piece of glass, say three nches square, is covered with squares of mica, each of a quarter of an nch square; upon each of these squares a different number is printed, unning consecutively from No. 1 upwards. The figures are written in a ellow, transparent, nonactinic varnish. Square No. 1 has one thickness f mica, but No. 2 has an additional square of mica placed upon it, and o on; thus each number represents the number of sheets of mica through which the light must pass. The whole is cemented or fixed together so s to make one convenient sized plate, and thus arranged it is placed pon a piece of ordinary paper prepared with a solution of bichromate f potash of the strength before mentioned. On exposure to the light he glass has a uniform light yellow appearance, caused by the yellow int of the paper, and the yellow figures have about the same tone. The ction is as follows: commencing with No. 1 the paper changes to a dark rown, but as the nonactinic figures protect the portion they cover from he action of the light, the surrounding part only becomes dark, and the igures appear white by contrast; and successively as the action of the ight is continued the other figures appear, and a well-recorded scale of he accumulated force of the light is thus obtained.

Ingenious and useful as this little apparatus is it is scarcely equal to the requirements of a large establishment, and an application of the first men- tioned plan of printing to a unit of force has been proposed and is worth mentioning. One skilled person (a boy can attend to it) is employed with a strip of sensitive paper, and this is placed in a little frame, leaving exposed a small square, side by side with the colored standard; when the photographic paper has acquired the tint of the standard by its side another piece of photographic paper is exposed, and so on successively. It is easy to see the important application this is capable of. For instance, the frames of prepared carbon papers are run out upon little rails and exposed to the action of the light; they are kept in this position by a in or detent, and by a small notched wheel capable of adjustment, so hat any desired number of notches must come successively into position efore the detent will be released, and the frames run into the dark room

by weights acting on pulleys. The negative carries a certain number for the units of printing force required, and the printer when thrusting the frame out for the action of the light adjusts the detent to this same number. The attendant who is in charge of the printing as each unit is printed advances one of the notches, and consequently when the required number of units has been reached the detent is released, and the frame runs into the dark chamber. One skilled hand, therefore, has charge of the light, whatever number of frames may be printed, and the uniformity of exposure for each negative is secured.

When the exposure is finished the gelatine face of the tissue is laid upon a bath of caoutchouc dissolved in benzole, and is then at once hung up to dry. In about two hours it is sufficiently dry for the following operation: a piece of caoutchouc paper (paper covered with a thin layer of caoutchouc,) is taken of the same size as the printed tissue and placed upon it, the still sticky surface of the covered tissue adheres to the caoutchouc paper, and the two pieces are passed through a rolling press. From this they are at once thrown into a bath of water at a temperature of about ninety degrees Fahrenheit; in about ten or fifteen minutes the unchanged gelatine becomes softened and can be gently separated from the caoutchouc paper. When the original piece of paper is removed, a large portion of the unchanged and soluble gelatine and the insoluble portion forming the picture is retained with the caoutchouc paper. The water is kept at the same temperature, and in about half an hour the remainder of the soluble gelatine is removed, leaving the perfect picture of pigment in insoluble gelatine; the clean picture is then dried and floated face down on a bath of pure gelatine, or with a slight mixture of glycerine with it. When it is again dried, the sheet of paper intended to be the permanent mount is dampened, and placed upon the print, and both are passed through the press. The two papers may now be placed in a bath of alum or other substance to insure the conversion of all the gelatine into an insoluble form, and when dried the print is ready for the final operation, which consists in moistening the caoutchouc paper with benzole and detaching it from the print, which can now be mounted in any desired way.

It will be seen that the photograph thus obtained is composed of insoluble gelatine and carbon, or other indestructible pigment, and is in all respects as permanent as an engraving.

WOODBURY'S PROCESS.

The process of Woodbury is carried on thus: a sheet of gelatine is placed upon a thin sheet of mica, and soaked in a bichromate solution: it is then placed with the mica side to the negative, and exposed to the light; after exposure the soluble portion of the gelatine is washed away, and the picture is thoroughly dried. This picture, which is in relief, is placed upon a clean plate of lead or other soft metal, hydraulic pressure is applied, the gelatine picture is impressed, and the mold thus obtained

used for printing in the following manner: a few drops of warm gelane mingled with any desired pigment are placed upon this mold, and moderate pressure is applied with a glass plate or other flat surface; he superfluous gelatine exudes, leaving only the depressions filled with he ink, and the varying thickness of the pigment gives the light and hade of the picture. Many of the specimens are remarkably beautiful, nd they cannot ordinarily be distinguished by the casual observer from he finest photographs. The process is almost as rapid as type printing, nd there is no doubt that a great future in this art is here opening. There are many practical difficulties to overcome, but the process is in ll respects one of great promise.

DRIVET'S PROCESS.

The process of Drivet for engraving plates is not described, but the rinciple of it can be gathered from the specification of the patent. At he same time that the image of the object is thrown on the prepared ollodion plate in the camera, the image of a sheet of white paper, covred with closely ruled black lines, is thrown upon the same plate, and t the same time, through another opening from an exactly opposite irection. A negative is thus obtained which would print a positive icture having the required lines in the high lights obliterated, and ntensely developed in the deep shadows. A gelatine picture printed as n Woodbury's process, gives the matrix from which an electrotype plate s produced, to be printed from as an engraved copper plate. It will be een that we have here the very elements of mezzotint engraving, and he results are undoubtedly the most beautiful and practical yet achieved.

APPLICATIONS OF THE PHOTOGRAPHIC ART.

Among the applications of photography, which, as might be expected, as spread into all departments of science and art, there is one of considerable practical value, which will here be noticed in detail. It is new nd ingenious, and likely to be of great value in surveying, whether in lan or elevation.

APPLICATION OF PHOTOGRAPHY TO SURVEYING.

For some time past in the corps of engineers in the French army, surveying has been practiced by plotting from the sketch made by the *mera lucida*, and a memoir on this method by Captain Laussedat in the *Memoire de l'officier du génie*," *Vol.* I, *No.* 16, 1854, explains the working it, and its advantages.

Following up his researches, M. Laussedat, in 1864, then *chef de bataill- n du génie*, in the same work fully described his adoption of photoaphy for the same purpose, and the writer takes pleasure in giving me account of the means employed, and the results obtained by the

system, which has been very ably carried out in practice by Captain Javary of the same corps.

For the complete details of the process reference should be made to the two volumes mentioned, but the general idea of the work will be comprehended from the following description:

The apparatus employed is a theodolite and camera combined. Starting from a measured base-line, of about five hundred meters in length, the camera is erected at one extremity and perfectly levelled. Some known or well marked object in the view is noted and the angle it makes with the base-line is measured. A photographic view is then taken and the operation is repeated at the other extremity of the base-line.

From these two photographs the process of plotting afterwards proceeds. Each of the pictures is a vertical projection of all the points included in the view, formed by the rays or imaginary lines drawn through these points and the center of the lens to the sensitive plate in the camera. Inasmuch as the center of admission of the lens is made to coincide with the station point at each extremity of the base-line, and the angular distance of some well-marked object is determined by measurement, and the image of this object is brought, by turning the camera, into the center of the field of view, it is only necessary to erect the pictures so taken perpendicular to the plane of the map to be drawn, and to place them in the proper position with respect to a base-line previously drawn upon the paper, to give the means of obtaining the location on the map of all the points included in both of the views.

For convenience of description the stations at the ends of the base-line may be indicated by A and B, and the point or object of which the angular distance is observed from both A and B, by O. Photographs are taken from A and B, with O in the center. In practice, paper prints are taken from the negatives. On the picture taken from station A a line, M N, is drawn at its base parallel to the horizon line. A perpendicular line is then drawn from the image of O on the print to M N, and similarly from other objects in the print, as, for example, C and D. The points of intersection, *c*, *o*, *d*, of these perpendiculars on M N, constitute the horizontal projection of the photograph. A base-line is similarly drawn upon the photograph, taken from station B, and may be indicated by M′ N′ and the intersections of the perpendiculars by *c′*, *o*,′ *d′*.

In plotting, the object O is first located upon the map by means of the observed angles at A and B. The photographic print taken at A is then laid flat upon the paper, with the line O *o* on the print coincident with the line O A on the map, and the distance A *o* equal to the focal distance of the lens.

Lines are then drawn from A passing through the points *c* and *d*. The photographic print obtained from station B is then similarly placed upon the paper. The points *c′ d′* are then marked and lines are drawn through them from B, then the intersection of the lines thus drawn from B through *c′* and *d′* with the lines drawn from A through *c* and *d* will give the proper positions upon the map of the object C and D.

The process of determining the heights of points above the level of e stations involves, first, the determination of the distance from a ation as above, and, second, finding the tangent of the angle of elevaon or depression from the photograph by measuring the distance at ght angles to the horizon line of the picture between the horizon line id a line drawn through the given point parallel to the horizon. This stance is the tangent of the angle of elevation or depression, but to a dius equal to the distance from the station point to the point of interction of a perpendicular to the horizon line of the picture, through the ven point, with the line at the base previously mentioned, the photoaph being located on the plane of the map as described. Having tained these elements, the height of a point can be readily plotted. The economy of this process is evident, and the details obtained by it e so complete that all the undulations of surface, even of a mountains district, can be given with marvelous fidelity.

One measured base-line is sufficient, and from it the work proceeds as ordinary triangulations.

Some of the results of Captain Javary's surveys, exhibited in the position made by the French war department, are as follows:

In Favarge, Savoy, where the mountains are about two thousand three ındred meters in height, twelve thousand hectares were surveyed in the ar 1866 in eighteen days of field-work and five months of office work. ntour lines or levels five meters apart were mapped down on the tire area.

In 1867, at St. Marie aux Mines, (Vosges,) six thousand to eight thound hectares were surveyed in twelve days of field-work and two months the office. Sixty-three negatives were taken for this work.

At Passage du Bonhomme (Vosges) five thousand hectares were suryed in four days' field-work, twenty-two negatives being taken from ven stations, affording work for two months in the office.

At Langres and its environs eight thousand hectares were surveyed fifteen days. One hundred and ten proofs were taken, and two months the office completed the work.

Compared with ordinary triangulation in the field and the office ork which it requires, the economy in time by Javary's method is as ie to three or four, but a comparison between field-work alone done ith the theodolite and with camera gives a far greater economy in favor the latter, for a few minutes suffice for the camera to record an innuerable series of points from which both the horizontal distances and e altitudes can be afterwards obtained, while it would take as many urs to note down a few of the same points with the theodolite.

APPLICATIONS IN ASTRONOMY.

One of the most beautiful applications of the photographic art is in cording astronomical phenomena, and particularly, as exhibited at the position, in delineating the inequalities of the surface of the moon,

and in recording the dark lines of the solar spectrum. The photograph of the moon exhibited by Lewis M. Rutherfurd, esq., of New York, gave an excellent idea of lunar topography. It was a print from an enlarged negative of the moon, about twenty-one inches in diameter. The original was taken in New York on the 6th of March, 1865, the moon being then about three days past the first quarter.

The instrument with which this negative was made is described in an article on "Astronomical Photography" published in the American Journal of Science, May, 1865. The only peculiarity of this instrument is that the objective (eleven and one-quarter inch aperture, and fourteen feet focal length) is corrected solely with reference to the photographic rays, and is consequently useless for vision.

The first negative of the moon was made in the focus of the objective, and is about 1.5 inch in diameter. From this a positive on glass, of about the same size, was taken with a camera, and the large negative from which the prints are made was enlarged from this positive, using sunlight thrown by a heliostat through a triple achromatic condenser and a three-inch globe lens.

The photograph of the solar spectrum was combined from ten negatives of the spectrum made in the years 1862 and 1863. The combined prints form a spectrum about forty-two inches in length, extending from a point in the blue-green, not far from the line known as *b*, to a point in the ultra violet, near the line designated as *I*. This embraces all of the spectrum containing chemical rays of sufficient power to aid in producing an image upon ordinary collodion.

Upon this print twenty-one hundred lines may be counted. It is upon a scale of about half the magnitude of the great chart of Kirchoff, and while it contains all his lines, exhibits very many which he did not place upon his map.

The negatives from which this print was made were taken with a spectroscope of the ordinary construction, using two prisms of sixty degrees, filled with bisulphide of carbon,[1] thus producing a dispersive power equal to that of four prisms of the same angle constructed of the ordinary optical flint glass.

The telescopes have objectives of one and a half inch aperture, and nineteen inches focal distances. The sun-light is thrown upon the slit by a heliostat, and a condenser is used for the fainter portions at the ends. The time of exposure varied with the position of the negative from twenty seconds to five minutes. The shortest time required was for that portion of the spectrum near the line G, and the longest near *b* and *i*, the two extreme negatives.

[1] The spectroscope, and particularly the method of making the prisms, is described in an article published by Mr. Rutherfurd in the American Journal of Science for 1864.

PHOTOGRAPHIC APPARATUS.

LENSES.

t progress has been made in the manufacture and construction of particularly with respect to an enlarged field and correct delinea- An angle of 60° or 70°, and in Zentmayer's American lens even ı now be obtained with a good landscape lens or a copying lens, 30° could scarcely be expected ten years ago. Prominent among t makers are Dallmeyer and Ross, in England; Darlot, in France, set of combination lenses; Voigtlander, in Austria; Steinheil, in a; Busch, in Wurtemberg; and Harrison, of America, for his ens. Zentmayer's lenses made in the United States were not

JUTE'S HOLDER FOR GLASS PLATES.

e from lenses, photographic apparatus is extremely simple, and ovations exhibited are so unimportant that, with two exceptions, e not worthy of special notice. One of these novelties is a very contrivance invented by Mr. Jute, a cabinetmaker, and patented

Fig. 1.

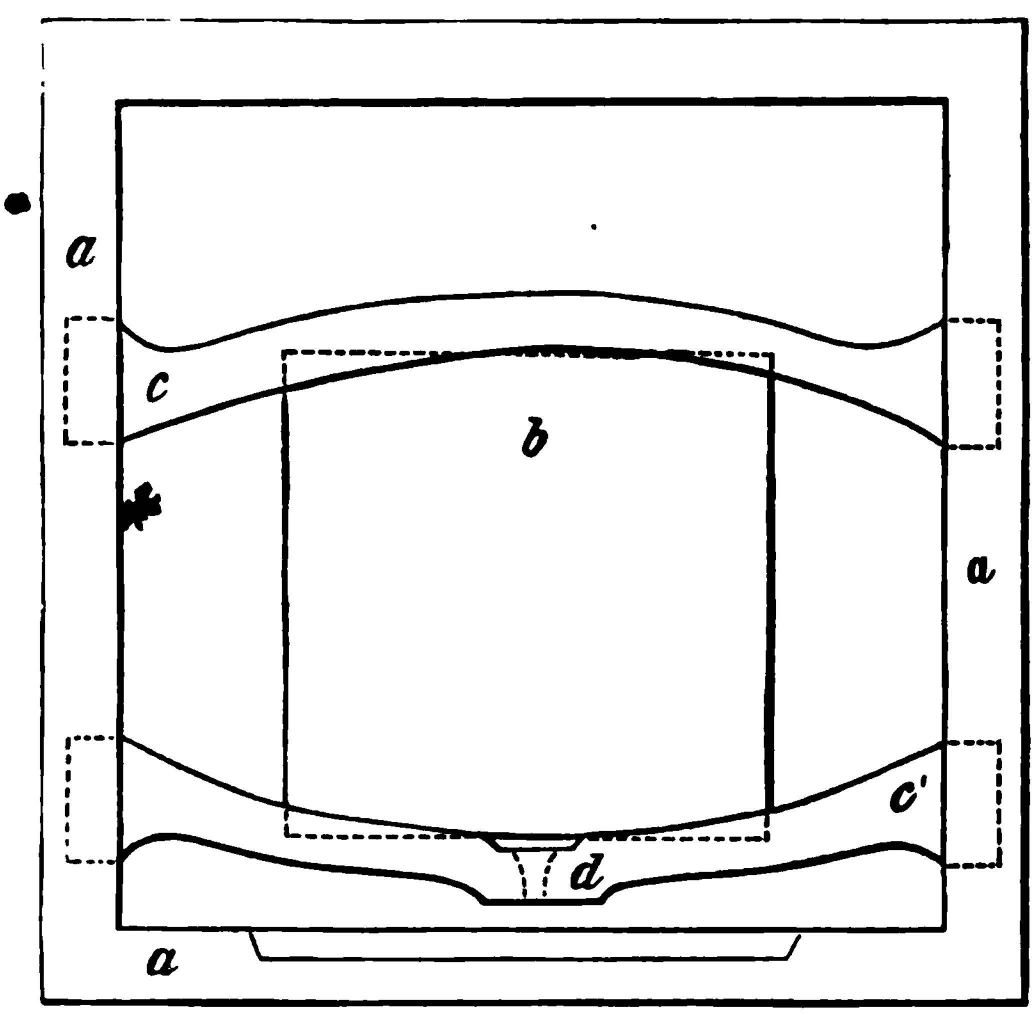
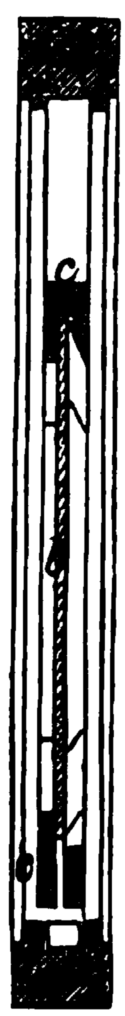


Fig. 2.



Jute's Universal Holder for Glass Plates.

in France March 5, 1866, and exhibited in the French section srs. Garin & Company. It is designed to take and hold a glass f any size. Fig. 1 is a front view of this instrument, and lateral section in which *a* is the holder and *b* the glass plate. w-shaped cross-bars *c* and *c'*, capable of sliding vertically in the are grooved for receiving the glass. One side of each of these

grooves is flat, so that the glasses must necessarily come to the same plane or focus. A small trough or receiver *d* is formed in the lower cross-piece for receiving the nitrate of silver which drains from the glass.

Photographers in the habit of using different frames for the different sizes of glass they employ will readily appreciate the simplicity and convenience of this arrangement.

JOHNSON'S PANTOSCOPIC CAMERA.

The second apparatus to be noticed was one of the most conspicuous objects in the photographic exhibition, and is known as J. R. Johnson's pantoscopic camera, patented in the United States November 28, 1865.

The instrument is represented in plan Fig. 3, and in elevation Fig. 4. It consists of three main parts: firstly, a circular stationary metal disk *a*, attached to the tripod *b*, in a horizontal position; second, a camera *c* placed on the disk, and furnished with rollers to facilitate its rotation round the same; and, third, a travelling box *d*, also provided with rollers resting on the rail *e* of the camera, on which it travels during its rotation with the camera. Motion is imparted to the instrument by clock-work placed in the camera in such a manner that, while the camera with the traveling box is made to move in one direction, the holder follows an inverse rectilinear direction on the rail *e*; by this means a photographic representation of the entire horizon is obtained on one plate at a single operation.

For the purposes to which this instrument has hitherto been applied, viz., landscapes and groups, this extensive range of delineation is unnecessary, and therefore the inventors have limited the range of their instruments to 100°.

It is evident that this novel apparatus must lead to many important results, of which we will enumerate the most prominent.

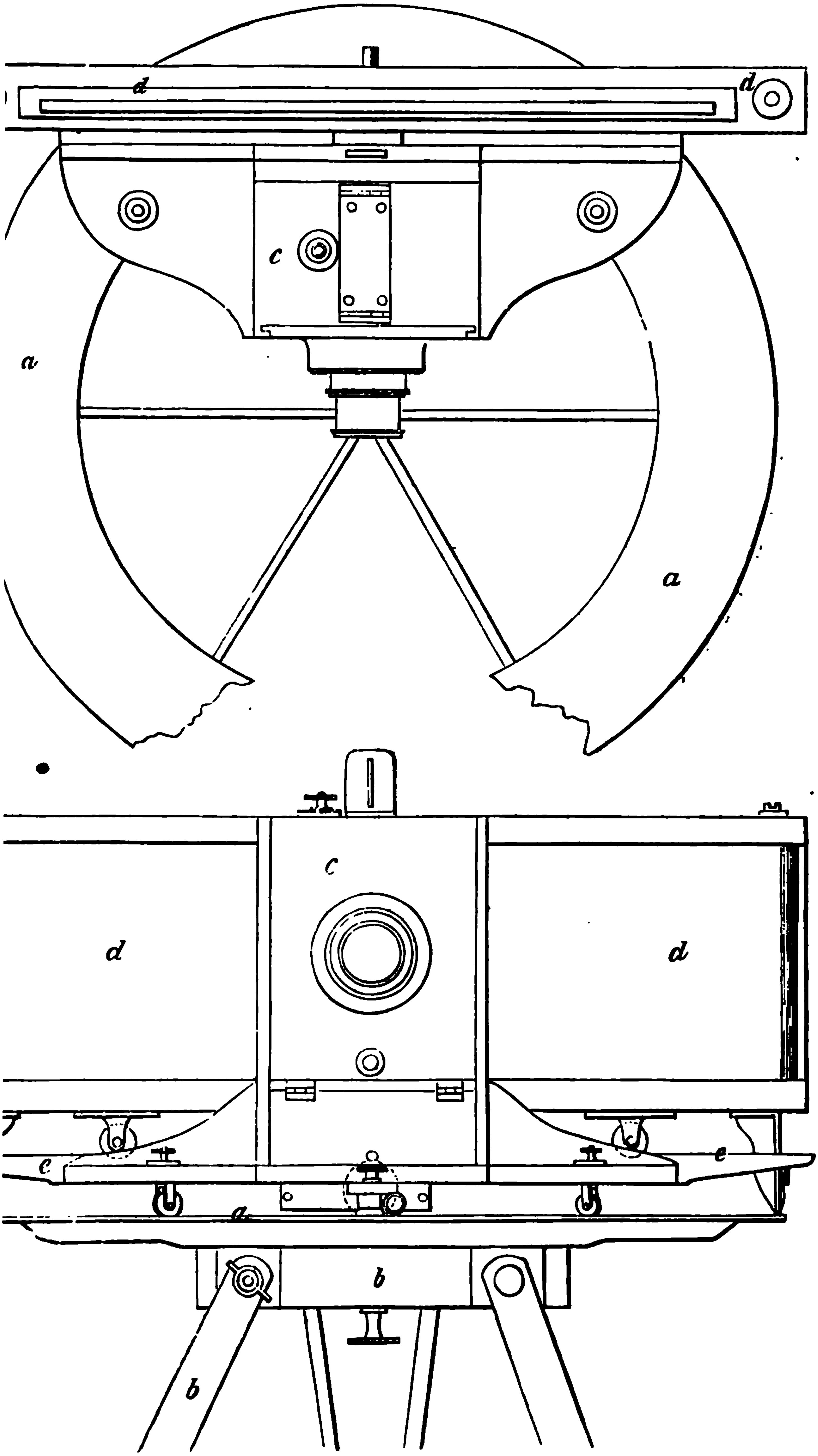
First. The range of the instrument in its limited form is twice that of the best lenses known.

Secondly. The views produced are focussed throughout their entire length, that is to say, they are equally as sharp at their extremities as they are in the center; this is evident, inasmuch as every part of the plate moves in succession under the center of the field.

Thirdly. Skies, with clouds and distant objects, which are always over-exposed in the ordinary camera, are faithfully rendered under all circumstances conjointly with the landscape. This result is secured by a vertical diaphragm placed in the camera, with an aperture at the top about four times larger than at the bottom, so that four times more exposure is given to the landscape than to the sky; the size of this aperture can be varied at will by means of adjustable cheeks.

Fourthly. The vertical lines throughout the picture are strictly perpendicular, due to the diaphragm above mentioned, which intercepts all lateral rays proceeding from the lens.

Fig. 3 and Fig. 4.



Johnson's Pantoscopic Camera.

Fifthly. As the axis only of the lens is employed in this instrument, much greater rapidity of action is obtained.

Many forms of this instrument were exhibited by Mr. Johnson in the English section, and by Mr. Brandon in the French section, and the finest specimens of landscape photography, obtained with these instruments, were to be seen in the English, French, and Swiss sections. M. Braun, the celebrated photographer of Dornach, Haut-Rhin, has, we are informed, a collection of upwards of 2,000 different sized negatives produced by this ingenious instrument.

PORTABLE PHOTOGRAPHIC APPARATUS FOR TOURISTS.

A very ingenious apparatus for taking pictures in the field, without the encumbrance of a tent or dark chamber, was shown by the firm Geymet & Alker, Paris, France.

It is the invention of M. Octave Nicour, and it is so portable that it may be carried in the pocket like an ordinary opera or field glass, which it resembles. One tube serves to show the image of a landscape or other object on a ground glass plate, and the other tube contains the sensitive plate prepared with dry collodion.

The tourist holds the instrument in his hand, and, when he wishes to take a picture, admits the light into the dark tube by a movement of his little finger. For such persons as are not able, after a little practice, to hold the camera sufficiently steady to secure a sharp picture, a portable cane tripod is supplied, to the top of which the little camera can be attached.

The dry collodion plates are carried in a circular or disk-shaped box, which has a narrow opening on the periphery, through which they can be withdrawn and passed into the camera without being exposed to the light. They can be returned from the camera to the box in the same way, and are subsequently treated for the development of the picture by the ordinary processes in a dark closet.

The box is made capacious enough to hold fifty plates of small size, but large enough to satisfy amateurs and for use in enlarging.

The whole apparatus, including the fifty plates, does not weigh more than two pounds and a half.

By the improved processes now in use, collodion plates are made that retain their sensitiveness to light for months. Moist collodion plates can also be used, but the apparatus becomes less portable and convenient.

APPLICATION OF ELECTRICITY TO PHOTOGRAPHY.

Messrs. Geymet & Alker have applied electricity to photography by causing it to open and close the camera when a person is sitting for a picture. The operator calculates the time required for the exposure of the plate according to the intensity of the light, the time of day, &c., and then adjusts a needle upon a dial so as to give a corresponding time

' movement to a piece of clock-work. When all is ready for a picture, touch of a button opens the aperture of the camera, the clock is set ı motion, and at the expiration of the allotted period the clock breaks ıe circuit, the aperture is closed, and a bell is rung to call the operator.

This contrivance is particularly useful in cases where the sensitive ılate is to be exposed for a long time; for the operator after once deciding ıpon the time and setting the clock in motion, need not attend upon the nstrument, but can be occupied with other matters until he is called by he bell.

PARIS UNIVERSAL EXPOSITION, 1867.

;PORTS OF THE UNITED STATES COMMISSIONERS.

OUTLINE

OF THE

TORY OF THE ATLANTIC CABLES,

BY

H. F. Q. D'ALIGNY,

UNITED STATES COMMISSIONER.

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ATLANTIC TELEGRAPH CABLES.

The laying of a telegraphic cable across the Atlantic ocean, by which e eastern and western hemispheres have been brought into instantaous communication, is the greatest triumph of science over nature hieved within the present century. It is only about 30 years since e discovery of the electric telegraph. Its use was rapidly extended rer Europe and the United States, and, indeed, all the countries of e civilized world. It was found even possible to carry it for short disnces under the sea. The first successful experiment of this kind was ross the English channel, uniting France and Great Britain. Soon er, a submarine line was stretched across the North sea to other points the continent. The same means was used to connect the countries ng around the Baltic. In the Crimean war, a slender wire encased gutta-percha, the whole little bigger than a pipe-stem, was trailed ough the Black sea, by which France and England were enabled to mmunicate with their armies before Sebastopol; and soon after a huge ble was sunk in the Mediterranean, by which Europe was united to frica. But here submarine telegraphy was supposed to have reached limit. Many scientific men contended that it was impossible to carry a longer distance, at least with any prospect of its being permanent. veral great failures tended to confirm their apprehensions. And yet, the face of all this doubt and unbelief, and in spite of immense obstas, a cable *has been* laid across the Atlantic ocean, and is to-day in full eration, binding two worlds together.

The triumph of this immense undertaking is the work of two great tions—England and the United States. England has contributed st in money and in ships, but the origin of the whole enterprise, the pulse which first set it in motion, and which kept it in motion for more n twelve long years, till the final victory was achieved, came from the merican side of the Atlantic, and is chiefly due to the faith, the energy, d the strong will of one man. For proof of this it is only necessary to peal to the truth of history.

It was in the spring of 1854 that the enterprise was begun. A year two before, a project had been started to connect Newfoundland with e mainland of America by a line across that island. But it did not ntemplate a telegraph across the ocean, but only to reach the port of t. John's as the farthest point on the western side of the Atlantic, from hich a line of fast ships was to convey news in about a week to Ireland. deed, it was at first a matter of doubt whether a cable could be laid ross the Gulf of St. Lawrence, and it was proposed to send messages

over that arm of the sea by boats or carrier pigeons! But the scheme never came to anything. After a few months' effort it ended in a disastrous failure.

It was at this time that the manager in his extremity came to New York, and was there introduced to Mr. Cyrus W. Field, who was soon to take the burden on his shoulders. When the latter began to look into the project, it seemed to him a matter of small importance merely to gain two or three days in sending messages to Europe, but as he pondered it alone, turning over the globe in his library, the idea flashed upon him, *Why not carry a telegraph across the ocean itself?* That, indeed, would be something worth while. It was this new idea which took hold of his imagination, and kindled an enthusiasm which long years of discouragement could not exhaust.

But he did not undertake the work alone. That was too much for any one man. His first effort was to enlist a few men of large ideas and large fortunes who should combine their strength. Such support he found in three well-known capitalists of New York, distinguished alike for their wealth and benevolence, Messrs. Peter Cooper, Moses Taylor, and Marshall O. Roberts. With these was associated Mr. Chandler White, a retired merchant. These four gentlemen met with Mr. Field at his house, and there for four successive evenings, around a table, covered with maps and charts and plans and estimates, studied the route of the proposed telegraph and its probable cost. The result was an agreement to embark in the enterprise, provided a new and more favorable charter could be obtained from the colonial government of Newfoundland. To secure this Mr. Field, accompanied by Mr. White and Mr. D. D. Field, the legal adviser of the company, sailed for St. John's, where, after a negotiation lasting several weeks, they succeeded in obtaining a new charter granting them the exclusive right of landing cables on the coast of that island for fifty years, with other privileges, conditioned on the construction of a line of telegraph the whole length of the island and across the Gulf of St. Lawrence—grants to be still further increased when a cable should be carried across the ocean.

Thus the way was prepared for active operations. But now began a labor of which they had not dreamed. Knowing little of the country, they had not comprehended all the immense difficulties of the undertaking. The shortest route across Newfoundland is 400 miles, and their course lay through a wilderness. There were no towns and no roads. Save a few fishermen's huts along the coast, the country is utterly uninhabited. Supplies of all kinds had to be carried around the coast in a steamer constantly employed for the purpose. An expedition was organized of 600 men to cut a way through the forest. It entered on its work as an army enters on a campaign. The hardships which they had to go through can hardly be estimated by those who undertake similar works in an inhabited country. Pelted by the rains in summer, and blocked up by the snows in winter, it seemed as if the enterprise would never be

mpleted. For more than two years they fought their way through the ilderness. But at length the end was reached, and the little army came it at the other extremity of the island.

Here it was necessary to cross the Gulf of St. Lawrence, 85 miles wide. ooking forward to this, Mr. Field had gone to England in the winter 1854–'55 to order a submarine cable; but the attempt to lay it failed, id had to be abandoned for that year. Again he returned to England id ordered a second cable, which was sent out the following summer, id laid successfully. So that the work of establishing telegraphic communication between New York and St. John's, begun in the spring of 354, was completed in the autumn of 1856.

Up to this time (a period of two years and a half) this was purely an merican enterprise. Not an Englishman had put into it a single pound. ndeed, the project was almost unknown in England. The capitalists f London neither knew nor cared what a party of Americans were doing way in the forests of Newfoundland. All the money came out of the ockets of not more than six individuals, and chiefly from four. In 1856 Ir. White died, and his place was supplied by Mr. Wilson G. Hunt. n these few men rested all the burden of raising nearly $1,500,000, and f carrying on a work of such magnitude. The active management of he enterprise, the raising of the money, and all the expeditions by sea nd land, fell upon Mr. Field.

This work, great as it was, was but preliminary to one greater still. rom the beginning the projector had looked forward to an ocean telegraph as the final work to be achieved. With this in view, he applied o the American government for a ship to make soundings across the tlantic. In response to this request, the Arctic, under Captain Berryan, made a careful survey of the whole route from Newfoundland to reland, determining the existence of a vast submarine plateau fitted to eceive the cable in its tranquil bed.

While these surveys were in progress Mr. Field again embarked for ngland, and there, in the summer of 1856, associating with himself Mr. ohn W. Brett, who laid the first submarine cable across the English hannel, Mr. (now Sir) Charles Bright, and Dr. E. O. W. Whitehouse, ganized the Atlantic Telegraph Company, with a capital of £350,000, f which one-fourth was taken by himself alone. For the rest he, with r. Brett and others, went from city to city in England, addressing the hambers of commerce and enlisting capitalists. So contagious was their nthusiasm (for the enterprise was then new and had all the charm of ovelty, and public ardor had not been damped by repeated failures) that a few weeks the whole capital was subscribed, and the manufacture the cable begun.

It was at this time that Mr. Field applied to the English government, d succeeded in enlisting its powerful aid. In response to his letter to rd Clarendon, and after repeated interviews with different members of e government in which he explained the importance of the enterprise,

the government guaranteed an annual subsidy of £14,000, and offered its ships to assist in laying the cable. On his return to America he applied to his own government, and succeeded, after many months, in obtaining a similar subsidy of $70,000 per annum, with the offer of ships. As the result of this incessant activity, on both sides of the Atlantic, the spring of 1857 saw collected in English waters an Anglo-American fleet to undertake this great international work. The United States was represented by two of her largest ships, the Niagara and the Susquehanna, and England by the Agamemnon and the Leopard. The cable was embarked on the Niagara and the Agamemnon, the other ships serving only as convoys. The expedition sailed from Ireland on the 5th of August with cheers and prayers and benedictions. For two or three days all seemed to promise success, but when over 300 miles off the coast the cable broke at the stern of the Niagara, and the fleet returned to England, and the attempt was abandoned for the year.

But it was only to be renewed with fresh determination in the following year, 1858. Again the cable was shipped, as before, on the Niagara and the Agamemnon; but this time, it was thought, the chances of success would be increased by proceeding to the middle of the ocean, and there, joining the cable, divide, sailing to opposite shores. The plan seemed judicious, but it succeeded no better than that of the year before. Several times the cable was joined, but only to be broken when the ships were a few miles apart, and the fleet returned to England.

The prospects of the enterprise now seemed almost desperate. But one more attempt was resolved upon before it was abandoned; and, to the surprise and astonishment of the world, it proved a success. The cable was safely stretched from shore to shore, and for nearly one month continued to transmit intelligence across the waters. This sudden triumph, coming upon a public wholly unprepared for it, excited, especially in America, the greatest enthusiasm.

But a month passed and the cable was silent. Suddenly it ceased to work. Then came a great revulsion of public feeling. The ocean telegraph became the subject of doubt and derision. Men were ashamed of their enthusiasm, and now smiled at their own credulity in believing that it had ever worked at all. To bear up against all this odium required strong faith and firmness of character. But the projector never despaired even in the darkest hour. He still maintained, against all unbelievers, that "it could be done," and "sooner or later it would be." But it was long before the public mind rallied from the shock of its first disappointment. Then came on the great American war, and the nation was too much absorbed with the movements of armies, with battles and sieges, to be able to attend to anything besides. Nothing was heard of the Atlantic telegraph except as, from year to year, Mr. Field reappeared upon the scene, endeavoring to inspire new confidence for one more effort.

In England these years were profitably spent in a long course of experiments, undertaken by the government and conducted by the first scien-

fic authorities of the kingdom—Sir William Thomson and others. oo much praise cannot be awarded to those eminent men for their devoon to a science which was to render possible a great practical benefit mankind. Their conclusions all tended to confirm the possibility of panning the Atlantic. This, too, was being demonstrated in a practical ay. With experience came a more perfect knowledge of the conditions success. The great firm of Glass, Elliot & Co., especially, had acquired ich a mastery of the whole art of laying submarine cables that they most never failed; and the bold and assured tone in which they xpressed their convictions tended strongly to re-establish confidence. y these means public faith was so far restored that in 1864 the way was repared for a new attempt.

That summer Mr. Field went again to England, and there joining with ld friends and enlisting new ones, succeeded in restoring life to the tlantic Telegraph Company. The capital required was £600,000, which as obtained, after long exertion, in England and America.

In the construction of a new cable every improvement was introduced hich science or experience could suggest to render it absolutely perfect. t was of more than double the size of that in 1858, having much larger opper wires for its conductor, which was protected by many coats of utta percha so as to secure perfect insulation. It was then bound round nd round with strong iron wires, which, in turn, were wrapped in hemp, o that the whole cable had at once the flexibility of a common rope rith the strength and the tenacity of iron. The manufacture occupied bout eight months, extending through the spring of 1865. In June of hat year the work was complete, and the mighty mass was shipped on oard the Great Eastern, which had been chartered for the purpose; and n July that leviathan, with her precious freight, proceeded to sea.

In this expedition everything had been done to insure success, and yet he enterprise was again doomed to failure. For twelve hundred miles he cable was laid without injury, when, owing to the strain caused in auling it in to repair a fault which had gone overboard without being liscovered, it suddenly broke and went to the bottom. For nine days he gallant engineers and seamen dragged the ocean to recover the lost reasure; but in vain, and the Great Eastern returned unsuccessful to ngland.

This fresh disappointment produced a painful impression on the public aind. Those who had taken part in the expedition did not feel discourged, and in the freshness of their zeal they were ready at once to begin new. But the great public, which has to be relied upon to sustain ich enterprises, responded slowly. Scarcely had Mr. Field returned to merica when the ardor began to wane; and when, at the close of the ear, he went back to England, he found the project in a state of susense, almost ready to be abandoned. As the last hope of obtaining esh resources a new company was organized, called the Anglo-American elegraph Company, with a capital of £600,000 sterling. Mr. Field sub-

scribed £10,000, and nine others put down each an equal sum. The Telegraph Construction and Maintenance Company stood on the books for £100,000, and thus the whole capital was soon secured. The manufacture of the cable was even more rapid than that of the year before. Though it was the first of March before it was begun, on the last day of June the Great Eastern left the Thames with it all on board, accompanied by three attendant ships, and in four weeks the iron cord had been stretched across the ocean, and messages were passing along the bed of the Atlantic as freely as through the British channel.

But the work of this memorable voyage was not ended. After a few days' rest the telegraphic fleet returned to the middle of the ocean and began to drag for the cable lost the year before. Nearly four weeks were spent in this apparently hopeless task. Thirty times the long line was let down to a depth of more than two miles, and the grapnel was dragged along the oozy bottom of the deep. Several times the cable was grappled, and once brought to the surface, but escaped. But on the last night of August it was finally caught, and after thirty hours' labor it was brought on board; and being spliced to seven hundred miles of cable which had been reserved for the purpose, it was carried safely to the western shore. Thus were completed two Atlantic cables, by which telegraphic communication was finally established—never again, we trust, to be interrupted—between the Old World and the New.

This brief outline of the history of the Atlantic telegraph reads like a romance, but in its progress it was a stern reality. From the beginning of the work in Newfoundland to the completion of this double line across the ocean was a period of twelve and a half years—years of immense labor and sacrifices—all the more difficult because made in the face of repeated failures and almost universal discouragement. For the greater part of that time the scheme was derided as the wildest folly, and those who embarked in it as visionary dreamers. To contend against this strong current of popular unbelief and even derision required a faith and courage and perseverance of which history presents few examples. Such qualities deserve to be honored, especially when they issue in a result which brings distant nations together and promotes the intercourse and the peace and happiness of the whole civilized world.

All who have taken part in such a work deserve to be regarded as public benefactors, and there is no need to depreciate the merit of one to exalt that of another. There is glory enough for all. Great honor is due to the governments of England and the United States for their enlightened efforts to promote what was truly an international work.

In the early expeditions the navies of the two countries were equally represented, and American and English officers and seamen worked side by side in generous rivalship for a common result. The scientific men of the two countries also showed their interest in the work. Professors Morse and Henry and Bache, and Lieutenant Maury, gave it the benefit of their knowledge and counsel even before it had attracted the general

ttention of the scientific men of England. So the capitalists of New York embarked in the enterprise years before their example was followed by the capitalists of London. These services, where rendered by Englishmen, have been duly recognized by the British government in the distribution of knighthoods and baronetcies. But in all the history of this enterprise, no intelligent reader can fail to see that one figure stands foremost—that of the American who began the work when the very idea was hardly known to the world, and who followed it for more than twelve years, till he saw it victorious. In the course of these years he crossed the ocean more than forty times, besides his frequent voyages to Newfoundland. He was the main instrument in getting up the three different companies which were organized to prosecute the work; he was in all the five expeditions that sailed to lay the cable; and thus on sea and land, in England as well as in America, his was the active brain out of which came the plans which were destined to such a glorious fulfilment; he was the soul and mainspring of the whole mighty work.

The relative parts borne by him and those noble Englishmen with whom he was associated have been well defined by Sir William Thomson, of the University of Glasgow, who himself had a distinguished part in this enterprise, and who knew its history from the very beginning. At the late meeting of the British Association for the Advancement of Science his name was received with deserved honor and applause for the brilliant part he had taken in that great achievement. In his reply, after acknowledging the compliment, he said:

"I feel that you have done me too great an honor in coupling my name with that great, that famous enterprise, the completion of telegraphic connection between Europe and America. It is to that embodiment of patriotic enterprise, the Atlantic Telegraph Company, that the result obtained is owing. No company has worked through so much discouragement, animated by a desire to carry out a great benefit, not only to the two nations chiefly concerned, but to the whole world. The Atlantic Telegraph Company is a British company, and well may England be proud of it. But America, too, had a great part in the undertaking. Cyrus Field, a citizen of the United States, originated the Atlantic Telegraph Company. He supported it through its difficulties year after year; when its prospects seemed so low that the public was discouraged—when no one would produce money, the great essential in an affair of that kind—he came over to this country and took the opinion of scientific men and of practical engineers, who, by the semi-successful attempts that had been made, had been led to see that the difficulties might be overcome. In this way he persuaded the public that the enterprise was possible. The money was found and the enterprise was continued year after year. He came over and elevated our spirits, and set the enterprise going again when it was on the point of failing. I shall never forget the day when we last gave up hope of finishing the work in 1865. On that day Cyrus Field renewed a proposal for the adoption of the plan which

has been adopted, and which has led to the successful completic enterprise. Cyrus Field's last prospectus was completed in th saloon of the Great Eastern, on the day when we gave up all 1865. But Cyrus Field could not lay the cable without the co-o of those who executed the work; and therefore I thank you in t of the Atlantic Telegraph Company, the Telegraph Construct Maintenance Company, the Great Eastern Ship Company, and th American Telegraph Company."

A most just tribute to these four companies which so nobly c for the completion of this marvellous enterprise; yet with the fi of a true Englishman does this eminent man of science acknowle an American was the originator of the great design, the inspire cessive expeditions, and the organizer of victory.

Such achievements naturally attract the admiration of manl work which unites two hemispheres; which, in the words of Joh "by its cables moors the New World close alongside the Old, example even in this age, and justly deserves a high place of an Exposition which aims to recognize the great achievements o all nations.

SUBMARINE TELEGRAPH CABLES.

[In successful working order, December. 1868, the insulated wires for which were manufactured by the Gutta Percha Company, London.]

Date when laid.	From—	To—	No. of conductors.	Length of cable in statute miles.	Length of insulated wire in statute miles.	Depth of water in fathoms.	By whom covered and laid.	Length of time the cables have been working.
1851	Dover	Calais	4	27	108	....	Wilkins & Wetherly, Newall & Co., Kuper & Co., and Mr. Crampton.	17 years.
1853	Denmark, across the Belt		3	18	54	....	R. S. Newall & Co	15 years.
1853	Dover	Ostend	6	80½	483	....	Newall & Co., and Kuper & Co.	15 years.
1853	Frith of Forth		4	6	24	....	R. S. Newall & Co	15 years.
1853	Portpatrick	Donaghadee	6	25	150	....	do.	15 years.
1853	Across River Tay		4	2	8	....	do.	15 years.
1854	Portpatrick	Whitehead	6	27	162	....	do.	14 years.
1854	Sweden	Denmark	3	12	36	14	Glass, Elliot & Co.	14 years.
1854	Italy	Corsica	6	110	660	325	do.	14 years.
1854	Corsica	Sardinia	6	10	60	20	do.	14 years.
1855	Egypt		4	10	40	....	do.	13 years.
1855	Italy	Sicily	3	5	15	27	do.	13 years.
1856	Newfoundland	Cape Breton	1	85	85	360	do.	12 years.
1856	Prince Edward's Island	New Brunswick	1	12	12	14	do.	12 years.
1856	Strait of Canso	Cape Breton, Nova Scotia	3	1½	4½	....	Nova Scotia Electric Telegraph Company	12 years.
1857	Norway, across	Fiords	1	49	49	300	Glass, Elliot & Co.	11 years.
1857	Across mouths of Danube		1	3	3	....	do.	11 years.
1857	Ceylon	Main land of India	1	30	30	....	do.	11 years.
1858	Italy	Sicily	1	8	8	60	do.	10 years.
1858	England	Holland	4	140	560	30	do.	10 years.
1858	do	Hanover	2	280	560	30	do.	10 years.
1858	Norway, across	Fiords	1	16	16	300	do.	10 years.
1858	South Australia	King's Island	1	140	140	45	W. T. Henley	10 years.

Submarine telegraph cables—Continued.

Date when laid.	From—	To—	No. of conductors.	Length of cable in statute miles	Length of insulated wire in statute miles.	Depth of water in fathoms.	By whom covered and laid.	Length of time the cables have been working.
1858	Ceylon	India	1	30	30	45	W. T. Henley	10 years.
1859	Alexandria		4	2	8		Glass, Elliot & Co	9 years.
1859	England	Denmark	3	368	1,104	30	do	9 years.
1859	Sweden	Gotland	1	64	64	80	[redacted]	9 years.
1859	Folkstone	Boulogne	6	94	144	38	[redacted]	9 years.
1859	Across rivers in India		1	10	10		[redacted]	9 years.
1859	Malta	Sicily	1	60	60	70	[redacted]	9 years.
1859	England	Isle of Man	1	36	36	30	do	9 years.
1859	Suez	Jubal island	1	220	220		R. S. Newall & Co	9 years.
1859	Jersey	Pirou, France	1	21	21	15	Glass, Elliot & Co	8 years.
1859	Tasmania	Bass straits	1	240	240		W. T. Henley	9 years.
1860	Denmark	Great Belt {14 miles {14 miles	6 3	28	126	18	do	8 years.
1860	Dacca	Pegu	1	116	116		do	8 years.
1860	Barcelona	Mahon	1	160	160	1,400	do	8 years.
1860	Minorca	Majorca	2	35	70	250	do	8 years.
1860	Iviza	do	2	74	148	500	do	8 years.
1860	St. Antonio	Iviza	2	76	152	450	do	8 years.
1861	Norway, across	Fiords	1	16	16	300	Glass, Elliot & Co	7 years.
1861	Toulon	Corsica	1	195	195	1,550	do	7 years.
1861	Holyhead	Howth, Ireland	1	64	64		Electric and International Telegraph Company	7 years.

1862	England		4	2	8	—	Glass, Elliot & Co.	6 years.
1862	Across River Tay						Electric and International Telegraph Company	6 years.
1863	Sardinia	Sicily	1	243	243	1,200	Glass, Elliot & Co.	5 years.
1864	Persian gulf		1	1,450	1,450	190	W. T. Henley and Indian government	4 years.
1864	Otranto	Avlona	1	60	60	569	W. T. Henley	4 years.
1865	La Calle	Biserte	1	97½	97½		Siemens Brothers	3 years.
1865	Sweden	Prussia	3	55	166		W. T. Henley	3 years.
1865	Biserte	Marsala	1	164½	164½		Siemens Brothers	3 years.
1866	Valencia	Heart's Content	1	2,160	2,160			
1866	....do	....do	1	2,214	2,214			
1866	Lowestoft	Nordernay	4	256	1,204			
1867	Cuba	Florida	1	286	286			
1867	Placentia, Newfoundland	Sydney, Cape Breton	1	351	351			
1868	Malta	Alexandria	1	1,180	1,180			
	Totals			13,289	13,506½			

NOTE.—A great many cables of short lengths, not included in this list, are now at work in various parts of the world; and other cables, the wires insulated by the Gutta-Percha Company, have been laid by Messrs. Felton & Guilleaume, of Cologne, during the last eight years, amounting to over 1,000 miles, and which are now in working order.

PARIS UNIVERSAL EXPOSITION, 1867.

?ORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

UPON THE

,TURE AND PRODUCTS OF THE VINE,

BY

MARSHALL P. WILDER,
ALEXANDER THOMPSON,
WILLIAM J. FLAGG,
PATRICK BARRY,
Committee.

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CONTENTS.

CULTURE AND PRODUCTS OF THE VINE.

RAL OBSERVATIONS UPON AMERICAN AND FOREIGN WINES.

exhibition of wines at the Universal Exposition of 1867 was large. wine-growing country of Europe, as well as Australia, Canada, nia, and other sections of North and South America, were repre- . As there were no jurors from the United States our American were not subjected to so full and fair an examination as they were d to, and to remedy this omission a special committee, consisting undersigned, was appointed by the board of commissioners to n examination of the wines of our own and other countries, and ort especially with reference to wine-growing in America. To ly judge, however, of the different kinds, of the qualities, cost, san- nfluence, and adaptability to our country—points upon which we have been glad to report more fully—would require more thorough ; and more time than the Committee could command, or had a right and from the courtesies of foreign exhibitors or commissioners. ards French wines, full reliance cannot be placed on what is fur- to the American traveller at hotels or cafés, or even what is sold the shops, no matter what price he pays. It would, however, be French wines a great injustice to judge them by the qualities sold way, or exported to America. The great body of American con- s have palates as yet so unskilled, and the merchants of Bordeaux bricators and imitators are so adroit, that it seems impossible for nest wine-grower here to come into such relations with the wine- rs there as will secure to the latter the benefits, sanitary and which the French people themselves derive from the pure juice grape so abundantly produced in this country. It is not an unu- actice for dealers to buy of producers in the back country a coarse, ed wine, for 30 cents per gallon, and a strong white wine for 45 er gallon, mix and bottle them, and send them abroad labelled ll the high-sounding names of Medoc, to sell at enormous profits uspecting foreigners.

her south than Bordeaux, in the country about Montpelier and s, an inferior article, but perfectly pure, can be obtained of the er at five and six cents per gallon, or one cent per bottle. Of late and since the abatement of the grape disease, the production of has been very large, the 4,000,000 of acres in cultivation yielding rage of 1,200,000,000 of gallons, which would give to every man, and child in the country a half-bottle-full every day, even after g 200,000,000 of gallons for exportation.

Owing, perhaps, to the intimate relations between America and Germany, our wine commerce with that country is conducted in a much more satisfactory manner. A good deal of excellent German white wine now makes its way to us, and is highly appreciated.

Hungary, whose product is second to that of France only, can supply a wide range of varieties, and at prices extremely reasonable. As the Hungarian producers seem to know, as yet, but little of the art of adulterating wine, we suppose their wines to be generally pure, and as they are not yet fully introduced into the markets of the world, we should think they might be advantageously purchased to a greater extent than has yet been done.

Besides the sherry, of which we consume so largely, Spain has an abundant and rich vintage with which American consumers would be better acquainted if her merchants had more of the enterprise of those of Bordeaux.

Portugal also produces plenty of excellent and pure wines of which we know little, for hardly a drop is allowed to leave the country without its being so strongly brandied as to lose its character as a wine, and become rather a spirituous liquor. Port wine is repeatedly dosed with spirits until it contains at least as much as 24 per cent. of alcohol. Fifteen years' age is required before it is fit to drink, not because the wine is slow to ripen, but because the spirit needs to remain 15 years before the disturbance it causes can subside, and antagonistic ingredients of the mixture harmonize. Notwithstanding bold and persistent assertions to the contrary, it has been satisfactorily proven to your Committee that the adulteration is made not to preserve the wine, but solely to make it sweet and stimulating.

As America is destined to become a great wine-producing country, her people ought to be better acquainted than they are with the higher grades of foreign wines, but they have as yet drunk so little of these that their standard of excellence remains comparatively low. Now, except in California, none of the European vines will grow in America, and we are compelled to search in our forests and develop in our nurseries and vineyards the varieties which are in the future to be our reliance for competing with foreign producers, and finally, it is to be hoped, emancipating ourselves from them altogether. Of course, then, the higher our standard of taste is, that is, the higher our aim, the better will be our success. Our vine-growers have much more to learn of the character and quality of good wines than they have of cultivation and manufacture, for really, as to the preparation of the soil, planting, cultivating, pruning and training the vines, gathering, selecting, and pressing the fruit, fermenting and keeping the wine, (white wine, at least,) our experienced *vignerons* have but little to learn of European rivals.

Our American vineyards compare very well with those of France, and so do our cellars, presses, and casks; so that an elaborate report on *methods* would be of but little benefit, and might even mislead, for

there seems to be no one method in use here, in any stage of vine-raising or wine-making, concerning which there is not a confusion of practice and a conflict of theory such as it would be hopeless to attempt to reconcile. Probably sound reasons for much of this diversity may be found in peculiarities of soil and varieties of vines that are local and special, and with which we have nothing to do. Still, a pretty thorough tour among the vine districts of France has not been wholly barren of suggestion.

CULTURE OF THE VINE IN EUROPE.

SOIL AND EXPOSURE.

The soil of Medoc, where stand "Chateau Margaux," "Château Lafitte," and "Château La Tour," is a bed of coarse gravel, among whose pebbles the eye can barely detect soil enough to support the lowest form of vegetable life. In the vicinity of Béziers, on the other hand, the land is rich and strong enough to yield any kind of a crop. Yet Medoc grows wine that often sells for $10 per gallon, while that of Béziers sometimes sells for the half of 10 cents per gallon. In Burgundy there is a long hill, on whose dark red ferruginous limestone sides a wretched thin covering of earth lies—like the coat of a beggar, revealing, not hiding, the nakedness beneath. Here stand little starveling vines, very slender and very low; yet here is the celebrated "Clos-Vougeot," and this is the hill and these are the vines that yield a wine rivalling in excellence and value that of Medoc, and to the fortunate proprietor the *Côte d'or* is what it signifies, "a hillside of gold." At its base spreads out a wide and very fertile plain, covered with luxuriant vines, whose juice sells at from 10 to 20 cents per gallon. If you go further northward and examine the hills of Champagne, you will find them merely to be hills of chalk. And these instances only illustrate the rule—derived not from them alone, but from abundance of others—that, for good wine, you must go to a dry and meagre soil. Yet we should be sorry to have to extend the rule, and say that the poorer the soil the better the wine, for there are certainly very few patches of ground in America that can match in poverty the mountains of Champagne, the hills of Burgundy, or the slopes of Medoc; nor would it do to conclude that manure should not be applied, for although some say it is hurtful to the wine in its quality, it is yet an open question whether this is so or not. Meanwhile the practice is to manure, although sparingly.

PREPARING THE GROUND AND PLANTING THE VINES.

This is probably as well understood in America as in France. We usually break up to the depth of two feet, and drain thoroughly. In many parts of France they trench to the same depth, but in many other parts this is impracticable, unnecessary, or injurious. Here the distance between the vines is from 18 inches to 2 feet, according to their size. We, however, are compelled, by the greater vigor of our vines, to plant them five and six feet apart.

In Burgundy, Champagne, and some other districts, it is the practice to renew the vigor of the vines by laying down the cane and rooting the plant in a new place, which quite breaks up the original lines, so the plough cannot be used. This is, doubtless, a good way to renew the strength of the plants, but it is objected to by high authority, on the assumption that the older the stalk is the better the wine will be. On the other hand, Champagne wine-dressers have attributed to this practice, in a great measure, their almost total exemption from the vine disease. But then, again, others attribute that exemption to the general and long-established custom of spreading over the vineyards a bituminous shale, containing sulphur, a well-known antidote; and here we would recommend most strongly to our countrymen a renewed and sustained effort to combat mildew with sulphur. The experience of France and other countries is entirely in its favor, and its use is still felt to be necessary and is still kept up.

We think Americans have not been thorough enough and patient enough. Let them try again, and this time let them begin early, and be sure to follow carefully these rules on the subject, which have been hitherto much better promulgated than observed. On rich and level land a common plan, in some districts, is to set out double rows of vines, at wide intervals, in fields chiefly devoted to other crops. The free exposure to sun and air thus secured seems largely to augment the yield, and this will be understood by any one who has noticed the superior productiveness of such of his vines as grow bordering on a wide alley or other open space. This is very different from planting vegetables, &c., among the vines, which is a bad practice.

WIRE TRELLIS.

These are becoming quite popular here, as we think they are in America also, notwithstanding the cheapness of wood. The size of wire preferred is No. 16, and but two wires are used. Our large vines would need three wires. They are stretched to strong posts, set 20 feet apart, passing intermediately through holes of smaller posts or stakes. On the lower line, about 18 inches from the ground, the fruit-bearing wood is trained, while the upper line, about 18 inches above the other, supports the new wood. Many prefer to allow the fruit-bearing cane to do service two years, instead of one only, as is the practice in America.

There is no doubt that with wire trellises the pruning, tying, picking off, &c., can be much more cheaply done than where the training is to stakes, and, from the way the clusters depend from the horizontal cane, it is easy to see that there must be also a superior access of sun and air and a greater ease in gathering the vintage.

WINTER PROTECTION.

It is a common practice to go through the vines with a plough every fall and throw up a good ridge of earth against the stalks. The Hun-

rians have a more effectual way of guaranteeing against the cold of eir rigorous winters, which is to lay the vines on the ground, cover em with straw, and on the straw throw the earth; without this, it is id, they could produce no wine at all. Our native grapes are generally ardy, and will live wherever their fruit will ripen; but occasionally ere is a severe season which seems to touch the very heart of the ood, and so enfeebles it that it falls an easy prey to disease. It was oticed that the mildew set in with great destructiveness after the two ard winters of 1854 and 1856. The thorough covering employed in ungary would secure it against such occasional risks, and also might nder it possible to grow European vines in our country. By its means, o, we could, perhaps, make the Scuppernong live in our northern ates, and obtain from it a sparkling wine, of foam and flavor unsurassed. From these considerations and others, we recommend to the ine-growers of our more northern States to lay down and thoroughly over their vines regularly every fall; and to those in milder regions, to ank up the earth against the stalks, as is done in France.

VINE-DRESSING.

We have derived most of our instruction in vine-dressing from the ermans, in whose native country there are no sunbeams to spare; and he celebrated Riesling grape is said to hardly ever ripen, and thus, perhaps, we have been led to attach too much importance to letting the ruit remain on the vine as long as possible before gathering. If we ave been in error, it would be well worth while to know it, for, besides he loss by shrinkage, the ravages of insects and birds, quadrupeds, and ipeds, during the last fortnight of the vine-dressers' watchings, is most isheartening.

PRODUCTION OF WHITE AND RED WINE.

Now, it is contended by good authority in France that early vintages re the best, and that it is important, not merely in regard to quantity but quality also, to gather the fruit before it becomes over-ripe. Possibly what is true of white wine may not be so of red wine, to which last-named kind attention is so widely directed in Europe. Here the proportion of white wine to red is very small, and it may be said that red is the rule and white the exception.

Our wine-growers in America understand very well the principles to be observed in the manufacture of white wine, and many of them, as regards care and nicety, are as good models as need be desired. But it annot be denied that the practice of selling the ripest and finest grapes or table use, and converting the unsalable into wine, prevails to a great xtent among American *vignerons*, and the result is the manufacture f much inferior wine. This has already injured the reputation of American wines both at home and abroad. Of the much more complicated rocess of making red wine, however, American manufacturers are but

little informed, for the reason that until recently they have had no grapes suitable for the purpose; but now that we have discovered those excellent varieties, the "Norton" and "Ives" seedlings, our estimate of the value of which has been very greatly raised by comparing wine from them with some of the highest grades of foreign productions, a few observations of methods of fermentation for red wine, as practiced in France, may be appropriate.

In France they will make either white or red wine from the same grape; but in America we have grapes whose pulp is so rich in coloring matter that they yield a very pretty-tinted wine without any further treatment than what is given to make white wine, and a pure white wine cannot be made from them. Of this kind is the "Norton" seedling. Yet not for beauty alone are they put through the process of fermentation on the skin, but because that process imparts qualities which, as affecting the palate, stimulation, digestion, &c., are quite different from what the other process imparts; many persons find red wine essential to their health who cannot use white wine, and *vice versa*.

MANUFACTURE OF WINE.

STEMMING.

The fruit having been gathered and selected, the next thing to do is to stem it. In Medoc and all the Bordelais this is invariably done. But in Burgundy and other districts they commonly omit it, and throw stem and all into the vat; if, however, the season has been bad, and the stems remain unripe, they are of necessity excluded in whole or in part, lest they do more harm than good. The chief reason for putting in the stems is to correct the disease called "tetter," for which the tannic acid, &c., of the stem is thought to be an antidote. Fortunately we know comparatively little, as yet, of any wine disease, except acidity, but still it will remain for us to decide upon experience which of the two methods it is best to adopt. Probably we shall arrive at the same diversity of practice as is witnessed here. Stemming is usually done by rubbing the fruit upon a grating of iron rods, but the better way decidedly is a grating of wood. It is made of bars two-thirds of an inch square, halved into each other where they cross so as to bring them down to an even face, leaving openings or meshes two thirds of an inch square. This is established like a table with four legs, with a rim around it about 10 inches high, and a proper receptacle beneath to receive and carry off the stemmed fruit, as it falls through, and the juice which escapes. The table is four feet square and four feet high. About three bushels of grapes are put on the grating, which four men with bare arms soon rub through, leaving the stems behind, which are then thrown into a small circular press, like our hand cider presses, which extracts the juice of the few grains remaining on them. In this way four men can stem enough to make 50 barrels of wine per day. For one who makes but a small quantity, a deep tub and a three-pronged stick will do very well.

CRUSHING.

This is next to be done by trampling the grape with the naked foot. t is said to be a better way than to use a large mill, for the reason that he mill will crush the seed; but the seeds are not easily crushed, and a roperly made grape mill need not bruise them in the least. At a well-anaged wine-house, that of Messrs. Averons Brothers, in Pauillac, hey put the grapes to ferment with no further crushing than what is iven them in the process of stemming, which, experience has satisfied hose gentlemen, is all that is needed.

Treading out grapes with bare feet is well enough, if the feet first be ade clean; but probably no American will ever adopt the plan of crushng with the naked feet, either clean or unclean, but will either rely on he crushing given in the stemming process, or use a mill, or a bucket nd tripod.

FERMENTATION.

The crushed mass, with or without the stems, is next thrown into vats nd allowed to ferment. The vats are large casks, generally without bulge, the largest at the bottom and open at the top. In some of the large houses they are covered with loose boards; in others the boards are jointed and made hermetically close by plastering with cement or clay; in others there is merely a floating mass of stems; and in others there is no covering at all except the scum of stems, skins, seeds, &c., which rise to the surface.

After the fermentation has ceased and the wine becomes clear, it is drawn off and put away in close casks, which in France are almost uniformly of the size called *barrique*, holding about 50 gallons. In Burgundy these are kept above ground and in the light until spring, and then put into cellars; while in the Bordeaux country they remain in the light in storehouses above ground until one or two years old, and then are removed to dark rooms on the same level. A careful way of making red wine out of grapes not fully ripened is to allow it to remain in the vats for a sufficiently long time after fermentation to let the greenness held in suspense settle to the bottom.

At La Tour, in the vintage of 1866, they allowed the wine to remain in the vat a whole month, though the fermentation was probably complete in half of the time. After drawing off, the remaining undissolved pomace is pressed and made into wine of inferior quality. It is common in France, and it would sometimes be necessary in some parts of America to provide means of warming the wine-house up to at least 20 degrees Centigrade or 68 Fahrenheit, as well as to introduce steam heat nto the vats themselves, which is done by means of a tin pipe entering o the right of the faucet and a little above the bottom of the vat, bendng to the bottom and rising again in the form of the letter U, and then assing out at the other side of the faucet, at the same distance from it,

the steam entering at one end and the condensed vapor escaping at the other; but heat is only applied in cold seasons and when the grapes are badly ripened.

VARIETIES.

In France the different varieties of fruit are commonly mixed together, and generally but little account is taken of *cesaye* (variety) as compared with the quality of soil. Well-informed persons, however, are disposed to complain of the introduction, which has been quite general of recent years, of coarse varieties grown for quantity rather than quality.

There is one variety of vine commonly seen on rich soil and deemed unfit for poor ground, except where grown for brandy, as in Cognac, that may possibly be of value to us. It is called "*la folle blanche enragé*." Except in its infancy it needs no stakes, but holds itself erect by the strength of its stalk, which is trained about one foot high, and from which the cane or branches shoot out with great vigor, like those of the osier willow pruned low. Every winter all the branches are cut back to two or three eyes, and during the season the ground is cultivated in the usual manner; but further than this it demands no attention. There is no summer pruning, nor any tying, winter or summer.

It is never hurt by frost, is proof against all disease, and is unfailing in its fruiting, and yields, when in good condition, 1,200 to 1,500 gallons of wine per acre. Its most favorable soil is a sandy loam, and when grown on such, its wine, which is quite strong, is worth 40 cents per gallon. Of that produced about Bordeaux, a good deal is mixed with coarse red wine and made into claret for American consumption. Of itself it will not make red wine. It is possible that this hardy vine or grape will stand our severe winters, and, with or without covering, obtain a footing in American soil. If so, every farmer, or whoever else can command a quarter of an acre of land, might raise for his own table an abundance of good sound wine at a trifling cost. Generally it is a bad policy to introduce a coarse plant of any sort; but we have so vast a spread of land that is too rich for growing delicate wines, no matter what variety of plant is tried, and of late mildew and rot have been so discouragingly fatal in many parts of the country, it might be well to give the "*enragé*" a trial, and, since we must drink the juice baptized with the names of "St. Julien," "Chateau-Margaux," and all the saints of Medoc, we may as well enjoy the satisfaction and the very large profit of raising it ourselves.

Not only do the French mix different kinds of grapes in the vat and on the press, but they freely compound together different kinds of wine in all stages of maturity. This is done, of course, with great care, the success of the merchant in his business depending on his skill in concocting what will please the palate. Such combination may be agreeable to the taste of the consumer and profitable to the merchant.

but it may well be doubted if it is as good for the health as that which is simply natural, and made from one variety of grape.

A French wine-grower has introduced the Catawba into his vineyard, and uses its juice to mix in very small proportions with that of native grapes to give flavor. Any considerable addition of the Catawba's musky quality would be more than the French palate, trained to like only that which is negative, could very well bear.

When American wines were tested by the jury at the Exposition, the French jurors, whose scale was from one to four, with a zero at the foot, generally complimented our Catawba with a zero, and they remarked that the more of the natural flavor the wine possessed, other things being equal, the lower they should estimate it. In America the very contrary is known to be the case. The German jurors, accustomed to wines of high bouquet, held quite different opinions from the French, and were much pleased with American wines.

TREATMENT OF WINE.

In regard to the more delicate wines of Europe which do not bear exportation, an important discovery is said to have been made by the distinguished chemist Pasteur, of the Institute, which is exciting great interest, and promises nothing less than to secure wine against disease and deterioration for an indefinite period, to enable it to be transported with safety any distance and kept in any sort of storehouse. The best way to make known in America the discoveries of M. Pasteur would be to translate and publish his very valuable work entitled "Etudes Sur le Vin," sold by Victor Masson & Sons, Place de l'Ecole de Medicine, Paris. Meanwhile we will give a brief synopsis of it.

After explaining at length the nature of the different diseases of the wine, acidity, bitterness, &c., tracing them all to vegetable parasites, and detailing his experiments in search of an agent to destroy the parasites, M. Pasteur arrives at the conclusion that they are effectually destroyed by heating the wine up to a point between 50 and 65 degrees Centigrade, which would be between 122° and 149° Fahrenheit. The heating can be done in a *bain marie*, that is, by placing the bottle or cask in a vessel filled with water and heating the water, or by hot-air closets or steam-pipes introduced into the casks. The heating should be gradually and carefully accomplished in order to enable any one to test the value of this invention, so important in its aims.

We extract the following, which gives all the author has to say on the mode he has himself followed with wine already in bottle, whether new or old, diseased or sound:

"The bottle being corked, either with the needle or otherwise, by machine or not, and the corks tied on like those of champagne bottles, they are placed in a vessel of water; to handle them easily they are put into an iron bottle-basket. The water should rise as high as the ring about the mouth of the bottle. I have never yet completely submerged them, but

do not think there would be any inconvenience in doing so provided there should be no partial cooling during the heating up, which might cause the admission of a little water into the bottle. One of the bottles is filled with water, into the lower part of which the bowl of a thermometer is plunged. When this marks the degree of heat desired, 149° Fahrenheit for instance, the basket is withdrawn. It will not do to put in another immediately; the too warm water might break the bottle. A portion of the heated water is taken out and replaced with cold, to reduce the temperature to a safe point, or, better still, the bottles of the second basket may be prepared by warming so as to be put in as soon as the first comes out. The expansion of the wine during the heating process tends to force out the cork, but the twine or wire holds it in and the wine finds a vent between the neck and the cork. During the cooling of the bottles, the volume of the wine having diminished, the corks are hammered in further, the twine is taken off and the wine is put in the cellar, or the ground floor, or the second story, in the shade, or in the sun. There is no fear that any of these different modes of keeping it will render it diseased; they will have no influence except on its mode of maturing, in its color, &c. It will always be useful to keep a few bottles of the same kind without heating it, so as to compare them at long intervals with that which has been heated. The bottle may be kept in an upright position; no mold will form, but perhaps the wine will lose a little of its fineness under such condition, if the cork gets dry and the air is allowed too freely to enter."

M. Pasteur affirms that he had exposed casks of wine thus heated in the open air or terrace, with northern exposure, from April to December, without any injury resulting.

Wine in the casks may be heated by introducing a tin pipe through the bung-hole, which shall descend in coils nearly to the bottom and return in a straight line and through the pipe imparting steam. If, after thus being once heated, there is such an exposure to the air, as by drawing off and bottling, as to admit a fresh introduction of parasites, the disease thus introduced may be easily cured by heating a second time.

M. Pasteur also claims to have discovered and proved that wine can be advanced in ripening and improved by aeration conducted in a slow and gentle manner. This is a bold assertion, but such confidence is felt in the value of suggestions coming from him that both of his methods, cutting, as they will, a tangle of old theories, will have a fair trial by his countrymen, and that without delay.

Your Committee would say, in conclusion, that from what comparison we have been able to make between the better samples of American wines now on exhibition at the Paris Exposition with foreign wines of similar character, as well as from the experience of many European wine-tasters, we have formed a higher estimate of the capacity of the United *States to* produce good wines than we had heretofore; and from our inves-

ations in vine culture we are now more confident than ever that nerica can and will be a great wine-growing country. All that is neces- y for us to rival the choicest products of other parts of the world will, long, come with practice and experience. We have already several ellent varieties of the grape borne on American soil, and suited to a soil extensive and varied enough for every range of quantity and ality. Who would discover a patch of ground capable of yielding a ohannisberger," a "Tokay," or a "Margeaux," need only make diligent d careful search, and, somewhere between the lakes and the Gulf, and two oceans that circumscribe our vineyard territory, will be sure to d it.

Accompanying this report is a paper from William Griffith, of Penn- vania, on the propagation of the vine, referred to us. This is med of such importance as to justify its publication entire, without nments on the subject by your Committee.

Finally, your Committee cannot close this report without acknowledg- the many courtesies extended to them by European exhibitors and d commissioners in facilitating the investigations incident upon the charge of their duties.

MARSHALL P. WILDER,
ALEXANDER THOMPSON,
WILLIAM J. FLAGG,
PATRICK BARRY,
Committee.

SUPPLEMENT.

NOTES UPON THE PRINCIPAL VINE DISTRICTS OF SWITZERLAND AND GERMANY.

The committee, since making their report on the third branch of the subject given them in charge, have visited the principal vine districts of Switzerland and Germany, and deem some of the observations there made worth being embodied in the supplemental report now submitted. The vineyards to which attention was more especially given were those of the borders of Lake Geneva, those of Pfalz or Rhenish Bavaria, and of the banks of the Rhine, the Neckar, and the Main.

With regard to the quality of the soil we have the same remark to make here as was made in the former report, viz., that the vines yielding the best wine were found to be growing on the poorest soil. Geologically the soil throughout all the above districts is very much the same, viz., basalt and sandstone, both formations usually seen in close proximity, the basalt uppermost and resting on the other. The only exceptions were a few patches of limestone and slate. The basalt soil is esteemed richer than the sandstone, and is often hauled on to the other to enrich it. For instance, the vine-dressers of Durkheim actually manure their thin, poor, gravelly land with tens of thousands of yards of earth, brought from the neighboring town of Deidesheim, and yet the Durkheim wine is quite superior to that of their neighbors. All this was quite different from anything we noticed in France; there calcerous rocks seem to underlie everywhere, nor could we learn of any wine of high repute in France that derived its quality from sandstone or basalt. The wine husbandry of the Swiss and Germans is of the first order. Nowhere do you see in their vineyards the straggling appearance so common in those of France, (the effect of frequent layering;) but the lines are always beautifully true and even. Although the intervals or rows were wide enough for the plough to pass, nearly all the cultivation was done by hand, and done most thoroughly too. In France, as in America, they stir the ground two or three times during the season. In the Rhinegau it is done four times, but about Forst, Deidesheim, and Durkheim, they do it as often as every two or three weeks from the beginning to the end of the season. It is in the above neighborhood that basaltic earth is applied as a manure, as is also clay, to make the ground more retentive of manure, and this they do to such an extent that old vine fields are seen which have been raised visibly above the level of the others adjoining them.[1]

[1] Some years since the vineyard of F. T. Buhl, of Deidesheim, produced wine on the natural soil of a very inferior quality, selling at fifty centimes the litre. At a very great expense

The expenditure of labor in a year on an acre of those fields amounts to about one hundred and forty days' work. In the Pfalz, it is usual to train upon horizontal laths or lines of wire, running fifteen inches above the ground, very much as is done in Medoc, only that where wire is used a second line is stretched above the other. If the plan is good in Medoc and the Pfalz, it is hard to see why it would not be good everywhere, especially in countries so cold as Germany and the northern part of the United States. Indeed, M. Guyot, to whose book we have already referred, argues strongly in favor of everywhere adopting the method of training the fruit-bearing cane horizontal with the ground and very close to it. We ought, however, to note here that the fields where this mode was more particularly noticed, or connected with good results, were in gravelly deposits of nearly level surface. Manure is freely used in Germany, much more so than in France, and is prepared and applied with much care and system. Cow manure, largely composted with straw, is the only kind thought fit to manure vines. They sprinkle the heaps almost daily to keep them moist, and allow the mass to rot at least twelve months before being used. It is applied every three years. As to quantity, it is certain that some soils, like the poor and unretentive gravel beds of Pfalz, should receive more than those of the neighboring slopes, and that the calcareous earths of France need less than the sandstone and the basaltic earths of the Rhine valley.

M. Guyot, arguing strongly in favor of manure, recommends the French cultivator to put on at intervals of three years a quantity of manure that will be equivalent in weight to that of the fruit he has taken off at vintage; while Mr. Herzmansky, the steward at Johannisburg, who tills some 50 acres of vines, keeps about 40 very large cows in his stables. *But will not manuring hurt the quality of the wine?*

In our fomer report we say that this is an open question as yet, and so it is in France, and M. Guyot treats it as such in arguing upon it. Of course, none will doubt that were a vineyard to be treated in this respect as we treat the soil of a grapery, very poor wine would be produced, and the only question is, will a moderate quantity do harm? This is precisely the question the committee put to Mr. Herzmansky, the intelligent and thoroughly experienced director at Johannisberg, where the best wine in the world is made. His answer was: "No; as we apply it on this soil it does not impair the quality of the wine in any degree, on the contrary, it improves the flavor." Then he led the way to his well-ordered cow stables, and pointing to the compost heaps remarked, "There is the beginning of Johannisberger."[1]

the whole vineyard was covered to the depth of three feet by volcanic or basaltic earth brought from a distance of several miles. The experiment at the time was thought to be a very hazardous one, but the enhanced value of the wines after the addition proved that the owner was wiser than his neighbors.

[1] The vineyard of F. T. Buhl, alluded to in a previous note, is fertilized by a compost made of wood-ashes, stable manure, and earth. This is applied in the spring, in trenches, dug to the depth of about 10 inches, and again covered with earth. The application is made in this

Now, Johannisberger is the most delicate of wine, as it is indeed superlative in every respect. By the kind invitation of the Princess Metternich, the committee were allowed to taste specimens of the best the castle cellar contained, including some that was 21 years old in the cask, and some from a cask that was *par excellence* called the "bride of the cellar," and the opinion formed was that the quality of Johannisberger is such that it cannot be described, and can be communicated only to the organs of taste, nor can it be understood or even imagined, except by those who are so highly favored as to have a taste of it. But this marvellous wine is but the crowning product of the famous district of the Rhinegan, or that portion of the valley lying just north of Mayence, a strip less than 10 miles in length, whose fruit yields a juice which surpasses all others of the world, combining richness with flavor, and delicacy with strength. The soil of the Rhinegan seems to be of a red sandstone mostly, if not wholly. Johannisberg hill reminds one strongly of the soil of some parts of New Jersey and Connecticut; and in the neighborhood of New Haven, in the latter State, the basalt is seen resting upon the red sandstone, just as it does upon the hills that skirt the Rhine. Nearly all the German and Swiss wines, and, indeed, nearly all the grapes grown in Germany and Switzerland, are white, for which the soil and climate of the former country seems peculiarly adapted, while at the same time unsuited for ripening colored grapes to the tint needed in a true red wine. The peculiarity of the better sort of Rhenish wines is "bouquet," and of the inferior sort acidity; compared with them, their French rivals are quite negative, and so are those of Switzerland.

A French wine, white or red, must be very poor indeed if it shows any acidity, and must be very fine indeed if it possesses any easily-tasted "bouquet." Altogether, we must award the palm of excellence to the white wines of the Rhine, as we do to the skill and industry of the vine-dressers who produce them. In considering the merits of the different soils, as geologically distinguished from each other, we seem drawn to the conclusion that, so far as our observation has gone, the red sandstone is the superior one, but we confess ourselves unfit to make any such sweeping generalization, and will only say that the soil in question, for aught we can see, seems as fit as any other to grow a superior wine. The difference between wine made by fermenting the bruised grapes, juice, skin, pulp, and seeds all together, and called "red wine," and that made by pressing immediately after gathering and fermenting its pressed juice by itself, called "white wine," is not a difference of color alone. For certain bodily temperaments, and for certain conditions of health, possibly, too,

manner to every alternate row in the vineyard. The following year the same process is gone through with in the remaining rows, by the removal of the soil as previously stated, and the treatment of manure as just detailed; this vineyard now produces wine of a very superior quality, of a delicious bouquet, rich in saccharine matter and alcohol, and possessing all those excellencies that we prize in a first-class wine, and is now readily selling at 12 francs the litre. To which is this wine most indebted for the extraordinary change in its character—to the volcanic soil, or the manure which is annually buried in the vineyard?

for the peculiar constitution of the German people, white wine may be the best. And to that of the Rhine country, Liebig attributes the virtue of being an antidote for calculus and gout. But all this being admitted, the better reasons seem to favor the production and use of the red wine in preference to the white where it can be done. The testimony we have obtained from the best sources of knowledge on this point amounts to this: red wine is much less heating, much more tonic, much less exciting to the nerves, much less intoxicating to the brain, and its effects are more enduring than white wine.

As we of America are, by reason of our dry climate, as well as from moral causes, more excitable, both from brain and nerve, than the Europeans, and at the same time much oftener in need of tonic diet, and our summer heats are so much more intense than in the wine latitudes of Europe, all the above considerations should have peculiar weight with us. So highly, at least, do the French people appreciate them that they consume now little white wine, and it bears always a lower price in the market than red of equal quality.

To the general consumption of this drink intelligent Frenchmen are apt to attribute the fine health of their peasantry, as well as their habitual gayety and habitual temperance. (The habitual use of *whiskey* has quite another effect.) An American gentleman, for many years residing in France, and for a time a professor in one of the universities, affirms that the greatest longevity is among those people who take red wine three times a day, and abstain from both tea and coffee. When Americans consult French physicians, three times in four they are ordered to drink red wine as a habitual beverage, and one of the commonest daily events among Americans residing in Paris is the cure of an obstinate dyspepsia by the same simple remedy, even in the unhealthful air of that city.

The German vineyards have hitherto escaped any very serious ravages from the vine disease. It is met as often as it appears, and successfully combated with sulphur. Three applications are made, the first as soon as the berries have grown to be as large as the head of a pin. Early in the day, and before the dew is dried off, the flour is sprinkled on the lower surface of the leaves, where the moisture causes it to attach. The implement used is a tube of tin perforated with numerous small holes at the lower end, and with a tassel of woollen yarn attached to that end.

At Rheims we were shown a large vine, trained to a wall, one-half of which had been treated as above in the spring of the year before and the other half neglected. The latter had, as a consequence, lost all of its fruit, and we visited the place and saw it the following season. It showed yellow and falling leaves in July, and very little fruit, while the other portion was perfectly healthy, and was loaded with a good crop of fruit. This experiment was made by a French gentleman, who had recently returned from a long sojourn in America, and visited that country for the

purpose of satisfying himself if the sulphur be really a preventive or not against the vine disease, of which he had heard so many doubts expressed while in America.

MARSHALL P. WILDER,
ALEX. THOMPSON,
W. J. FLAGG,
PATRICK BARRY,
Committee No. 9, United States Commission.

·APPENDIX.

PRODUCTION OF WINE IN CALIFORNIA.

SIR: In response to your request for information respecting the vine-rowing and the wine production of California, made during your exam-iation of the California samples at the Exposition, I now have the leasure to send you the following interesting résumé of the subject hich I have recently received from Mr. Carmany, editor of the Annual eview of the Mining and Commercial Interests of the Pacific States.

This article describes better than anything I have been able to prepare ıe present condition of the wine-producing interests of California.

I have inserted one or two paragraphs upon the soil of the vine regions, ıd have appended a list of the exhibitors of California wines.

Very respectfully, yours,

WM. P. BLAKE,

State Commissioner, California, to the Universal Exposition of 1867,
and Special Agent of the California Wine-producers' Association.

Hon. MARSHALL P. WILDER,
Chairman of Committee No. 9, *Universal Exposition at Paris*, 1867.

SOIL ADAPTED TO THE VINE.

The wine-growing interest during the past three years has been rapidly creasing in importance, and if unfavorable circumstances do not inter-ne within the next decade, will probably outrank in value any single ricultural product in the State. Our vine-growers find a great variety soil admirably adapted for vineyards, in conjunction with a climate, rather climates, which are more favorable for wine-making than can had in any portion of Europe. On the rolling lands and foot-hills on th the Sierra Nevada and Coast Range of mountains, which form the stern and western boundaries of the State, the soil, though varying mewhat in composition and proportion of ingredients, is mainly formed volcanic debris which produces grapes in the highest degree of per-tion known.

The soils along the slope of the Sierra Nevada present a great variety their appearance and composition. Some are derived chiefly from the integration of granite and metamorphic rocks, and others from clay-ites or sandstones or from a mixture of these materials with disinte-ated lavas. In extensive regions along the foot-hills the soil is formed iefly by the breaking down of lava and tufaceous deposits, or of the uvions of ancient rivers which are charged with materials of volcanic

origin. Some of the soils in the gold region which produce good grapes are quite red from the abundance of the sesquioxide of iron; in others oxide of iron is in small quantity and the soil has the ordinary clay color. In favorable locations very little irrigation is required, and in some places it is not necessary. Where there are mining canals or ditches along the hill-sides many vineyards below them receive water enough by percolation to sustain the vines during the most severe droughts.

The vines, as a general rule, bear abundantly, the exceptions being a few localities subject to late frosts in the spring, or occasional heated terms of a few days during some summers. These exceptions, however, are fully equal in productiveness to the average vine lands of Fra and Germany, and are only mentioned here to show that there are occa sional imperfections in a climate that would otherwise be without blem ish for wine-growing.

INTRODUCTION OF THE VINE.

The introduction of cultivated vines dates in California back to th establishment of the missions of the Catholic priests, who first settl in the southern portion of the State in 1769. These priests broug with them three varieties of vines taken from the neighborhood of Sevil Spain, and which, it was believed, were better suited to the climate California, and were more hardy and productive than any other kin Two of these vines (colored grapes) flourished well, while the third, white grape, was soon discarded from cultivation. The names of t vines are not now known, and being long acclimated, some of the pec liarities of the original stock have been changed, so that it is probab the so-called Mission vines will never be identified with the parent sto in Spain. General Vallejo, who is probably the best authority in t State on the subject, claims that the larger portion of the native gra cultivated north of Monterey, are a different variety from those gro south of that town and commonly known as the Los Angeles gra This statement is confirmed in part by the difference in size, color, sha of bunches and berries, and character of skin, the wine made in t different sections of the State also having distinct characteristics taste and aroma, which cannot easily be confounded together. For t purposes, however, of this article the vines introduced by the prie will be termed the native or Mission grape, as their product is to be co sidered in a commercial point of view.

California possesses the peculiarity of having distinct climates, as i were, in different portions of the State, the result of which is the pro duction of a greater variety of wine than can be found in any one countr in Europe.

WINE DISTRICTS.

Properly, the State should be divided into three wine districts, as the wines of each vary essentially from those produced in the others. For

convenience sake we will name them the Los Angeles, Coast Range, and Sierra Nevada wine districts. The first includes all that portion of the State lying south of Point Conception, comprising Santa Barbara, Los Angeles, and other southern counties. The wine made in this district, when allowed to ferment fully, contains from 14 to 16 per cent. spirit, has no decided aroma or bouquet, while the flavor is indifferent, with considerable taste of alcohol. The wine from this section was the first marketed in the State, and in the absence of competition soon had a large domestic consumption. As the other sections of the State made wines, the demand for the Los Angeles variety decreased, until at the present time the great bulk of the wines sold in San Francisco and exported comes from the Coast Range district.

This district comprises the foot-hills and valleys on both sides of the Coast Range mountains from Point Conception to the northern boundary of the State, a tract of territory about 400 miles long by 40 to 60 miles wide. In it are included Sonoma and other valleys whose wines have a general reputation second to no others in the State. They possess the peculiarities of the claret, Sauterne, and hock wines to a very great degree, and are the only acid wines of that character produced in California. Port, Angelica, Muscat, and other manufactured wines can be and are made in this district as well as in the others, but the fully fermented wines of Sonoma and other adjoining valleys have an abundance of tartaric acid, with a flavor, aroma, and bouquet not to be found elsewhere. Besides domestic consumption the acid wines of this district are fast growing into favor for exportation to New York and other markets, where, if received in good order, they are highly prized. The acid wines in this district contain from 12 to 16 per centum spirit, mostly averaging about 13½ to 14 per centum.

Wines produced in the Sierra Nevada district vary materially from the others, the tendency being towards sherry, Malaga, and similar styles of wines. With few exceptions they are of a straw color to brown, are dry in taste, and have a most decided flavor, bouquet, and aroma. Very limited quantities of red wines are produced in this district, the grapes containing little coloring matter compared with the same variety grown in the Coast Range district. From its advantages of climate, the season from April to October being continuously warm, and the vast area of country unfitted for any other production, this district promises eventually to be the greatest wine-growing section of the State. The general quality of its products, when known, will commend themselves to parties who prefer Spanish and Madeira wines to those of France and Germany, and probably not many years will elapse before a vigorous competition will commence for the entire market of the United States. The average percentage of spirit in the wines of this district varies from 14 to 20 per centum, according to the manner of manufacture.

STATISTICS OF PRODUCTION.

As stated in the commencement of this article, the wine-producing interest has been increasing rapidly within the last few years. According to the assessors' reports made to the surveyor general of the State for 1866, (the latest returns,) there were 19,710,814 vines planted, the largest counties being Los Angeles, 3,000,000; Sonoma, 2,830,195; and Santa Clara, 2,000,000. The total production of wine for the same year (by the same authority) was 1,791,633 gallons, of which Los Angeles county produced 600,000 gallons; El Dorado, 235,680 gallons; and Sonoma, 199,030 gallons. Of brandy there was produced in the same year 127,140 gallons, the largest counties being Los Angeles, 70,000 gallons; Sonoma, 6,838 gallons; and Sacramento, 5,714 gallons. The assessors' returns are known to be greatly understated in the actual quantities of vines planted and wines and brandy produced. Competent and well-informed parties put the number of vines actually planted in the spring of 1866 at fully 30,000,000 in the State, and the product of wine for that year at least at 2,500,000 gallons, and of brandy at least 200,000 gallons. For 1867 it is believed the wine crop was fully 3,500,000, and about 400,000 gallons of brandy. This amount is comparatively small to the product which may be expected in a few years, as in 1870 every vine planted in or before 1866 will be in large bearing. Besides this large number of vines then planted, a great increase will have been made, as new vineyards are being set out every year, and old ones added to, throughout the entire State. It is estimated that at least 3,000,000 cuttings are planted each year, and the practice will doubtless be kept up, in case profitable markets for wine can be had. Among the most gratifying features of this interest in this State is the steady improvement in quality of wine, showing care on the part of the grower, both in the making and after-keeping of the product.

VARIETIES OF WINE.

The minds of the wine-growers are also fast being disabused of a very common fallacy, that all varieties of European wines can be made from the Mission or Los Angeles grape. This change of opinion is insuring the propagation of the best varieties of foreign vines, both white and colored, hardly a vineyard now being set out which does not contain a large number of cuttings from the most famous varieties of France, Germany, Spain, and Italy. The varieties which are most in request for the purpose at present are the black Zinfindel, a Hungarian seedling of the black Pineaux, the true champagne grape of France; the white Johannisberger, and green Reisburg, and red Traminer of Germany; the white Malaga, Alicante, and Muscatella of Spain; Fihel Zagos and white Tokay of Hungary; the white and golden Chasselas, white and black Pineaux, Orleans, Chacelos du Foye, Montillardo and Catalyar of *France, and* the Verdelho of Madeira. All these varieties have been

tried in the Sierra Nevada district by various parties, the most successful and largest grower being B. N. Bugby, of Folsom. This gentleman has for several years been experimenting in wine-growing, having some 72 varieties of grapes in 56 acres of vineyard, all in full bearing. In 1866 he made separate wines of 19 different kinds of grapes, and in 1867 made 14 varieties of wine, some of them being made from mixed grapes. The result in every case where proper care was taken was the production of wines superior in many respects to those made from the Mission or Los Angeles grape. In Sonoma valley and Napa county several of the above-named varieties have been planted in large numbers, and not many years will pass before varieties of wine will be had in that district which will safely challenge the best wine of Europe to contest for superiority with them.

The great want of growers at present is more extensive markets for their wine, the home consumption being already largely supplied, so that but small increase in the local demand may be expected. Efforts are now being made to introduce the finer grades of wine, without chance of adulteration or injury during shipment, it being shipped per steamer, in glass in cases, so as to insure against all the above contingencies.

BRANDY.

In the distilling of grape brandy in California great progress has been made during the last three years. Prior to that time almost the total product was distilled from pumice, the skins, stems, and seeds of grapes after pressing. Where red wines had been made the pumice in many cases had fairly rotted before distillation took place, while in others the fusel oil contained in the seeds by crushing was set free to be vaporized with the spirit, it being a more volatile fluid. The brandy was made in the commonest kind of whiskey stills, which, combined with lack of practiced skill in making grape spirit, caused the production of an article that was full of gross imperfections, and had to be rectified before it was in fair marketable condition. The great increase in the wine crop in 1865 lowered prices so much that large quantities of wine in that and succeeding years have been made into brandy, while the stills have also been much improved in construction, as well as the skill of those using them. The result of these changes has been the production of a better class of brandy, which, in some instances, has been considered by good judges to be fully equal in quality to the best brands of France of similar age. That our brandy is improving is noticeable from the fact that it is now being extensively used in private dwellings, where French brandy only has heretofore been used. Among other enterprises inaugurated in this city during the past year has been that of the Pacific Refining Company, who rectified and improved the commonest kinds of grape spirit, so that it resembles in taste and aroma the medium grades of French brandy. Some of this brandy has been sent to New York, where it is reported to have been highly valued, and large orders are said

to have been received for it to be shipped to that place. The time is not far distant when both wines and brandy from California will be found on extensive sale in all portions of the Union, and on their intrinsic merits be considered equal to any varieties imported.

CHAMPAGNE.

The business of manufacturing sparkling wines or champagne on this coast has made great progress within the past year, and, in fact, the successful manufacture in California of pure sparkling wine with good bouquet and aroma is now admitted by all who have taken interest enough to inform themselves on the subject. The attempts at making sparkling wine in this State have extended over a period of 13 years, and although progress has, in some instances, been made towards producing a fine quality of wine, still the manufacture has been uncertain both as to quality and quantity, until the present time. In speaking of sparkling wine or champagne it is meant wine produced by natural fermentation in the bottle. This definition is particularly made to avoid confounding it with a fictitious effervescing wine that has been manufactured here very extensively for a number of years, and by its bad reputation has much retarded progress in true wine making. This last wine is made by putting ordinary still wine, sweetened and flavored, into bottles, into which carbonic acid gas is forced through the use of a soda fountain. The result is a liquid that gives headache, nausea, and general derangement of stomach to those who drink it, while wine made from natural fermentation is strictly healthful, and is prescribed by many physicians to convalescent patients as being more wholesome and stimulating than brandy of the best quality. The first attempts to make sparkling wine by natural fermentation in bottles was by Sansevaine Brothers, in 1855 and 1856 in San Francisco, they importing an expert from France for the purpose. After experimenting for two years without success they abandoned the attempt, and the same expert was engaged (after a visit to France) by Crevolin Brothers, who were also unsuccessful. The next party to try was Colonel Haraszthy, who failed, and was succeeded by the Buena Vista Vinicultural Society. This society commenced operations in 1863, and at great expense, after many attempts, succeeded in making limited quantities of good wine, which has been sold in this market during the past two years. Some idea of the difficulties attending the making of sparkling wine may be had from the fact that the different parties named expended over $200,000 before even partial success was attained. This is a comparatively enormous sum, but the following brief sketch of the operations of the Buena Vista Vinicultural Society, at their establishment in Sonoma valley, will show some of the risks in wine making. This society commenced in 1863, by putting up 9,000 bottles of wine which, failing to sparkle, were uncorked, and the wine sold for vinegar or distilling. The next year they put up 72,000 bottles, of which they sold between 500 and 600 dozen, and had to uncork the balance and dis-

pose of as in 1863, for making vinegar, &c. In 1865 they put up 42,000 bottles, which, fermenting too vigorously, after losing 50 per cent. by breakage, the balance had mostly to be uncorked to save the bottles. The wine uncorked was sold for the same purposes as in preceding years. In 1866 they put up about 40,000 bottles, (a portion of which is still in process of manufacture,) from which the officers of the society expect, in connection with the 1865 wine, to market about 2,000 dozen. In 1867 the society put up 90,000 bottles of wine, which, it is expected, will prove of excellent quality. All the wine used by the foregoing named parties was of the California grape, and considered well suited for champagne making. (This wine received "honorable mention" at the Paris Exposition, this being the highest grade of prizes awarded to any American wine.) In the spring of 1867, Isador Landsberger, who had associated with him Arpad Haraszthy, concluded to attempt the making of sparkling wine in this city, the latter named gentleman having been educated in France and served an apprenticeship for several years in some of the best champagne making establishments in that country. Making experiments with small quantities of wine, and using artificial heat to stimulate fermentation, these parties, after several failures, succeeded in making an excellent quality of wine, and at once engaged in manufacturing to supply the market. The first wine for sale was put on the market about the 10th of September last, since which time Mr. Landsberger has delivered an average of 200 dozen per month, say 750 dozen in all. The demand for this wine has been in excess of its production, so that preparations have been made to extend the manufacture in 1868 to an average of 600 dozen per month, deliveries at that rate to commence in April next. Finding it difficult to obtain wine of suitable quality for the manufacture, the proprietor of the enterprise purchased in advance 20,000 gallons of wine, the product of a desirable vineyard in Sonoma valley, and had the wine made according to instructions at the late vintage. The method of making the wine was different from the ordinary manner, and the result was so favorable that the wine was found of the desired quality and fit to move to this city within a month of the grapes being pressed. Believing that wine made in whole or part from foreign grapes would possess a finer bouquet and aroma, Mr. Landsberger has bottled considerable Muscatel, white Muscat and Reisling wines, which are now in course of manufacture. From the manner in which the wine is ripening, it is believed that a wine resembling sparkling Moselle in its most valuable qualities wil be produced. The manufacture of sparkling wines of good quality in California will not only benefit wine growers generally, by giving them a new market for their product, but will also drive out in time imported champagne, not only from this State but from the other sections of the Union. The home market of itself is a large one, the importation of French champagne in 1866 being over 11,000 dozen, which cost, duty paid, laid down to importers, fully $200,000. The importations for 1867 were still larger than those of the preceding year. The

lowest-priced champagnes sell at $15 per dozen; the second quality at from $20 to $22; and the best at $28 to $36 per dozen. The wine made by Mr. Landsberger is fully equal in quality to the second-class imported champagnes, and is sold for about half the price. Competent and disinterested judges who have examined the wine state that it will, in time, take high rank for its excellence, it needing a little age before drinking, and possibly a somewhat different flavoring. In the latter respect experience has shown that the ingredients used in France to flavor do not produce the same taste in California wines; also that the latter need no addition of brandy in making, as is the case in Europe.

PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

ON

SCHOOL-HOUSES,

AND THE

MEANS OF PROMOTING POPULAR EDUCATION,

BY

J. R. FREESE,

UNITED STATES COMMISSIONER.

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AND

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n this report the notices and inquiries are confined to the exhibits de in the Exposition by different nations. To go outside of this would olve an inquiry of interminable length, which could only be embodied volumes rather than in a portion of a single report of reasonable its. What, then, is there in the Exposition relative to school-houses l the means of promoting and extending popular education?

SCHOOL-ROOMS AND BUILDINGS.

)f rooms or buildings specially designed for educational purposes there only four in the Exposition, contributed by Sweden, Prussia, Saxony, l the United States.

SWEDISH SCHOOL-ROOM.

'he contribution from Sweden is a school-room on the first floor of a lding representing one class of the habitations of the country. The m is about 24 feet in length by 18 in width; height of ceiling about feet; lined with boards on the sides; bare beams overhead, and with one low double window at one end. Everything about the room is gh and uncouth. The building is not intended to represent the resi- ice of the teacher in connection with, or having charge of, the school, is only exhibited as a specimen of the habitations of the country. ıether the common schools of the country are ordinarily located in room of a private residence, as this represents, I am not informed, t presume from the exhibit that such is the case.

PRUSSIAN SCHOOL BUILDING.

The Prussian school building represents such as are usual in the vil- ;es of the country. It consists of two parts blended in one building. form is that of a T, with this difference, however, that the leg or part ich runs off from the cross is, in length and breadth upon the ground, out the same as the upper or cross building; the lower floor of the ter being used as the school-room, and the second floor of this, with of the balance, as a residence for the teacher. The school-room is out 30 feet in length by 20 in width; height of ceiling about 10 feet; stered within and well lighted. The ground floor of the dwelling rt consists of an entry-way, (used for access to the school-room as well for the dwelling part;) a sitting room about 15 feet square; a cabinet

or library room at the end of the sitting room; a bed chamber behind the cabinet, and a kitchen behind the sitting room. On the second floor are four other bed chambers, two over the school part and two over the dwelling part.

SAXON SCHOOL-HOUSE.

The third specimen school-building is from Saxony, and represents the normal rather than the common school establishments. It is in the form of a small Grecian temple, with four columns in front, and with niches, in which are vases, on either side of the main entrance. Its length and width, each, is about 28 feet; ceiling about 12 feet, and it is lighted from above.

UNITED STATES SCHOOL-HOUSE.

The fourth, and only other, school-building is the specimen contributed from the State of Illinois, of the United States, and is intended to represent the common cross-road and village school-house as connected with the common-school system of the State. It is a substantial frame building; weather-boarded and painted without; plastered neatly within; is 33 feet in length by 17 in breadth; has three high windows, which lower from the top, on either side, and two at one end; its ceiling is 15 feet in height, with a vestibule outside of the school-room, to which doors give entrance from either side, and from which two doors open into the school-room.

COMPARISON OF SCHOOL BUILDINGS.

In considering the question (with these, and only these, specimens before me) as to what, if anything, can be learned from other nations in the way of constructing buildings, or rooms, for educational purposes, I am forced to the conclusion that we can learn nothing to advantage, but, on the contrary, that other nations, if they choose, may learn from us.

The superior height of ceiling, with windows letting down from the top, of our school-room, affords full and free ventilation so necessary for the health and comfort of the pupils, while the large windows upon either side and at the end afford an abundance of light, and thereby saves the straining of vision, which is unavoidable where children are taught in rooms dimly lighted. The general appearance and neatness of the room, too, is far superior to either of the other exhibits, and it may be said that, if you wish to teach children habits of neatness and good order, you must have the room in which they are taught, and everything about it, neat and in good order.

The neatness of ours, as compared with the uncouth appearance of the other common school exhibits, illustrates another fact greatly in favor of the United States, namely, the superior social status which *teachers of* common schools hold in our country, as compared to that

held by them in most European countries. With us the teacher of even the cross-road or village school is held in high esteem, and is everywhere treated with respect due to his talents and personal worth, as well as to his vocation as an educator. In most European countries teachers of common schools hold a very subordinate position in the community in which they reside, not equal to that of the tradesman and mechanic, and their vocation is regarded as one of humility rather than of honor. "Once a schoolmaster always a schoolmaster," is the maxim with them, whereas, in the United States, the school teacher of to-day may be the minister, the lawyer, the doctor, or the congressman of five years hence, or, if a female, the wife of either, and the vocation itself, so long as pursued, is always regarded as one of honor and responsibility.

As to the Prussian plan of having a dwelling for the teacher connected with the school-room, it would hardly be generally practicable in the United States, as much the larger portion of teachers in our common schools are unmarried, and hence need no such family home. The idea, however, is not without its practical bearings, and where a teacher has a family it would certainly be a great convenience to him to have a dwelling connected with his school-room, as rectories or parsonages are connected with church edifices.

The plan of thus connecting the two is, I am told, very common in Prussia, and throughout most of the German states, and is found to be advantageous, in that it gives a fixed home to the teacher; relieves him from the payment of rent, and the acre or two of ground usually connected with such school edifices affords him pleasant and profitable employment when out of school. In sparsely settled neighborhoods of the United States it might be well to consider, when about to erect a school house, whether a dwelling part connected with it would not be expedient; for, even if the teacher has no family himself, he might, by having the control and rental of the dwelling, as part of his compensation, get a family to occupy it with whom he could board pleasantly; and if he should have a family of his own, the convenience, in such a neighborhood, would certainly be very great.

SCHOOL HOUSE FURNITURE.

The desks and benches in only three of the rooms can be described and compared, as the school-house from Saxony is not thus furnished.

In the Swedish school-room the desks and seats of the pupils are separate. The lids of the desks incline slightly inward or downward, while in the narrow level space at the top of each desk an excavation is made for pens and another for the inkstand; besides which, each desk is furnished with two brass supports, which, when lifted up, afford a place against which a copy or book may rest. The seats are made of plain boards, with board backs, in the form of a chair, but are rather rough in construction, and, we should think, very uncomfortable to sit upon.

The teacher's desk is supplied with drawers and other appliances, well arranged and in every way convenient.

The desks of the Prussian school-house consist of one long, flat board, about 12 inches wide, with no division or mark to indicate the space assigned to each pupil, and without any particular place for pens, ink, etc. Those exhibited are about 15 feet long, leaving about 2½ feet on either side between the end of the desks and the walls. The seats are like the desks, one long, flat board, only that they are 9 inches instead of 12 in width. They have no backs, or division marks to designate the place of each pupil. The teacher's desk is only a plain stand, without conveniences of any kind.

In the American school-house the desk and seat of each pupil is distinct and separate, and both are fitted up with a special view to comfort as well as convenience. Not only are they comfortable and convenient, but neat withal, and the most thoughtless or mischevious pupil would never think of using his penknife to deface either. Here, as in the case of the school-room, the remark will apply that neatness in the furnishing induces or begets habits of neatness in the pupils. The teacher's desk is fitted up with drawers and every convenience.

Of the three exhibits of school-room furniture the American is altogether the best, both as to convenience, comfort, and neatness, so that here, as in the case of the school-rooms, we can profit nothing from the exhibits of other nations.

APPARATUS FOR PROMOTING EDUCATION.

In considering school apparatus, and such other appliances as have been invented and used for promoting educaton, the exhibits made by two other nations, viz.: France and Spain, should be added to the list.

Commencing again with Sweden, a large variety of school apparatus of almost every shape and form, is to be found on exhibition, some of which is exceedingly ingenious and curious, and could scarcely fail to interest, while instructing the younger pupils. Colored counters, strung on horizontal wires, in an upright frame; small black-boards, with movable slides, on which letters and figures are arranged in different orders; another board, with movable metal type, which are placed and replaced in grooves and mortises, until the pupil has imitated the copy before him; blocks, demonstrating the various geometrical figures; maps and drawings in great variety, some of which are of superior execution; a large assortment of school books, primary, intermediate and classical; dried and pressed specimens of the flowers and plants of the country; and a small collection of minerals, form a general catalogue of this exhibit. We also find here models of gymnastic apparatus, such as are used in some of the schools of the country.

Passing to Prussia, about the same variety of school apparatus and appliances is to found as in Sweden, together with a few additions worthy of *note*—such as astronomical maps and atlasses of superior workmanship:

wings of steam engines and of other mechanical inventions; a large iety of drawing books, embracing almost every conceivable subject; sic books in great variety; and specimens of worsted-work and em-idery, done by the female pupils of their common schools. The addi-al exhibits indicate, in a manner, the special bent or inclination of popular mind, and the Prussians are found to excel in the very pursuits accomplishments which are taught thus early to their children.

n the Saxony exhibit is found most of the school apparatus and appli-es before mentioned, together with anatomical atlasses; a variety of ficial globes, admirably executed; maps, with a black background, wing the starry firmament, and others in *basso-relievo;* and a com-e set of blocks, illustrating the systems of crystallization.

PHYSICAL DEVELOPMENT—GYMNASIUMS.

he great feature of this exhibit is the beautiful model of the Normal nnastic School at Dresden, representing not only the buildings and unds, but each and every contrivance used in the exercises. This lel stands upon a large table or platform in the centre of the room, upying the entire space, except so much as is necessary to pass around The prominence given to this exhibit shows how large a share of ention the subject occupies in the minds of the educational men of the ntry, and may well awaken the inquiry in other countries whether e attention to this branch of physical education would not be bene-al? In Saxony, there is scarcely a common school to be found any-ere without a gymnastic department, and the educational men of the te consider it quite as important to develop the physical as the mental acity of the pupils. The same is true of other German states, though , perhaps, to so large an extent as in Saxony.

hat such exercises promote the general health as well as the devel-nent of muscle and nerve; and that mental development cannot pro-ss favorably and rapidly without sound health and a proportional elopment of the physical system, will be admitted by all; and, this nitted, it follows that a portion of the time devoted to education can-be better employed than in systematic gymnastic exercises.

A few schools in the United States, of the higher grades only, have led gymnastics to their other exercises; but it has not been made any of the States a part of the common school system; and the query v arises whether it might not be added with very great advantage? is report is not the proper place in which to argue the question at gth; its province is to state facts and throw out suggestions for the sideration of American educators.

SCHOOL APPARATUS IN THE SPANISH SECTION.

n the Spanish department of public instruction there is a larger iety of school apparatus and appliances for the promotion of educa-than in either of the departments heretofore mentioned. I had sup-

posed that Spain was so far behind all the rest of the civilized world in matters of education as to make no pretension to compete with other European nations in this particular; but the exhibit which she makes in the Exposition proves that in this I was mistaken.

In addition to the ordinary school apparatus and appliances found in the other exhibits there are several pieces of peculiar construction, showing not only great ingenuity, but a depth of thought and a wonderful and admirable precision of mathematical calculation. Among apparatus of this kind several movable calculating tables may be mentioned, which, by a simple adjustment, will give correct answers to mathematical problems which it would take hours to solve by the usual methods. It is a "*plano geometrico*," as it is called in Spanish, consisting of a board, about 18 inches square, in which holes are made with such mathematical precision, that, by placing wires with bent points and in lengths to suit the different distances of the holes from each other, any theorem of geometry can be accurately demonstrated. There is also a very complete series of models, showing the systems of crystallization, arranged in 18 distinct groups; and another apparatus, called a "mechanical tablet for teaching to read," wherein the letters or representative signs of simple sounds and articulations are separated in different groups. These letters and groups are printed on ribbon rollers, placed within a case, the face of which has small openings through which these letters and groups may be seen isolated or in combinations as the teacher may determine by the adjusting of little pins, and the turning of a crank at the end of the upright case. The apparatus is simple, though ingenious, and the advantage claimed for it is that it shows each letter *isolated*, and prevents thereby learning by rote, the pupil being necessarily led to distinguish the letters by their own distinctive forms and not by their relative order, as he too frequently does in primers, reading-frames, and reading books, in which letters remain always in the same relative positions in which they are printed. Moreover, as the pupil does not know which letter or combination of letters will appear at the opening his natural curiosity keeps him constantly attentive. There is, also, in the Spanish department a great variety of school books; a large number of drawings, some of which are admirably executed; and some handsome specimens of worsted-work and embroidery done by pupils of their schools.

SCHOOL APPARATUS IN FRANCE AND IN THE UNITED STATES.

The French exhibit of school apparatus, books, etc., is quite extensive, embracing almost everything usually found in schools, though there is nothing to be seen in the whole collection, which is specially new or advantageous. Indeed, in variety of apparatus and new school inventions, Spain excels France, a condition of things which no one could have expected from the general reputation of the two countries. Statistics show, however, that the number who can neither read nor write in France is very

great; and not until recently has the government given any special attention to the common schools of the country, though meanwhile giving much attention to the higher branches of education.

The exhibit of school apparatus and appliances by the United States comes next in order but neither in quantity nor variety does it equal the exhibits made by either of the other nations referred to. This is accounted for, however, in part, by the fact that our exhibit is intended to illustrate only such apparatus and appliances as are used in the cross-road and village school, such as the school-house itself represents, whereas the exhibits made by other nations include such as they use in their academies and higher grade of schools as well. What we do exhibit of maps, charts, artificial globes, geometric blocks, etc., etc., are quite equal in quality to the exhibits of other nations, and that we might have shown a much larger variety had we included such as are used in our higher grade of schools is well known to all who have any knowledge of the schools of our country. It is true, however, that the European exhibits show some articles of apparatus and appliances which have never yet been introduced into our schools.

BENEFICIAL RESULTS OF THE EXHIBITION.

Having thus taken a general survey of the exhibits in the Exposition relative to educational matters the query arises: What can we learn and wherein can we be benefited from the exhibits made?

In the structure of our school-houses and school-rooms, and in the comfort, convenience, and neatness of our school-desks and seats, we cannot, as has been heretofore intimated, learn anything by way of improvement, as ours are much superior to any others in the Exposition. Gymnastic exercises have already been spoken of at sufficient length, and conclusions may be drawn by the educational men of the country. Of apparatus and appliances, as explicit a description has been given as is possible without drawings, and from the hints thrown out the mechanical ingenuity of our educators can easily supply both drawings and improved apparatus if they think it expedient to do so.

One of the marked differences between a primary education in the United States and Europe is the greater attention which the educators of the latter pay to drawing, music, and mechanics. These branches are taught in most of our higher grade of schools, but have not been generally introduced into our primary or common schools. In Germany, and in some other portions of Europe, you will hardly find a boy or girl of ten years of age who has not considerable knowledge of music, and who cannot sing, or play upon some instrument, or both, with considerable skill; and the same may be said of the sketching or drawing of natural objects and mechanical inventions. That these accomplishments afford the possessors much real enjoyment, and tend to develop any latent talent they may possess of an artistic or mechanical kind, is undoubtedly true; and as a consequence of this early training Europeans excel in these very

branches. In these particulars we can learn an improving lesson from the Exposition.*

Again, in the exhibits of other nations collections of minerals, and of dried and pressed flowers and plants, peculiar to the country, are to be seen, and which, in a small way, are usual in their primary schools, as well as in those of a higher grade. In the United States geological, mineralogical and botanical collections are always to be found in our colleges, and often in academies or schools of a high grade; but seldom, if ever, in our primary schools. Such specimens are not only interesting as curiosities, but in case any of the pupils should be studying mineralogy, geology, or botany, they would be of great advantage by way of illustration.

It would be a very easy matter for any school in our country to collect in the course of a few years, quite a cabinet of minerals and a large variety of pressed flowers and plants, peculiar to the locality in which the school may be located. Let the teacher say to the pupils, "Bring me every curious stone, or flower, or plant that you may find, and I will arrange and clasify them in a way that will give you pleasure and profit," and he would soon have a collection of which he might well be proud. To these, additions could be made from time to time (better specimens taking the place of discarded ones) until the collection would indeed be one of scientific value, as well as of advantage to the pupils, and an ornament to the school-room. Herein, too, a lesson may be advantageously learned from the exhibits of other nations, and it would be gratifying to hear of the general adoption of this plan of collecting minerals and plants by the schools of the United States.

No just comparison can really be made between our own school system and that of European nations, for the reason that the political institutions and the people of our own and of European nations are so entirely dissimilar. What is acceptable to them, and probably beneficial, would not be at all acceptable or profitable to the people of the United States, and *vice versa*. Take, for instance, the laws of Prussia, the nation which is generally acknowledged to be in advance of all other European nations in educational matters, which direct that parents and guardians *shall* keep their children at school *all the while* from the age of 7 to 14, and affixes severe penalties for any neglect so to do. This places the entire direction and control of the public schools in the hands of the central government. Now, in Prussia, where a man will scarcely step across the road to visit his neighbor without a law authorizing or directing him to do so, and where all power is centered in the king and his advisers, such laws are practical and, probably, beneficial; but in the United States, where men will do from their own free choice what they could scarcely be made to do by compulsatory laws; where only the largest liberty of action—so long as it interfers not with the action or rights of others—is deemed compatible with republican institutions; and where *not only each* State, but each county, township, city, and town, claims the

ge of regulating its own school affairs in many important particu- uch laws could not be enacted, or, if enacted, would be wholly ative, as no man could be found who would complain of, and enforce w against, his neighbor.

hout attempting any extended comparison of the school system of nited States and those of European nations, this brief report upon -houses and the means of promoting and extending popular educa- respectfully submitted.

J. R. FREESE,
United States Commissioner.

PARIS UNIVERSAL EXPOSITION, 1867.

EPORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

ON THE

[UNITIONS OF WAR,

BY

CHARLES B. NORTON

AND

W. J. VALENTINE,

UNITED STATES COMMISSIONERS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
· 1868.

PREFACE.

'he undersigned, in presenting their report, desire to express their cere regret that the government of the United States had not comsioned some officers of the regular army to fill a position of so much portance—a position demanding often scientific research, and technical knowledge, such as only the professional soldier or engineer may be ected to attain. The first consideration of the undersigned has been obtain and lay before the government the best information on all subts referred to in their report. So, in order to supplement their own ited knowledge of some of the subjects treated on, they have made a eral use of such official documents as came within their reach, and o of any published accounts which appeared in the leading scientific l other journals of different nations. In adopting this course, they ieve that a more complete view of the entire field has been obtained in if they had relied solely on their own resources. It is also their ty as well as pleasure to state that in many cases they have received st valuable information and assistance from exhibitors or their agents. ough they are fully sensible of the danger of trusting to *ex parte* statents in matters of this nature, they believe that the inventor or maker generally best able to describe his own invention or manufacture; and the province of this report is not to decide upon or even to recommend provements, no danger can possibly result from thus endeavoring to ain the best information in regard to new inventions.

n dealing with a subject so comprehensive as "war materials," a cera classification was indispensable; hence the several divisions or pters, embracing small-arms, field and heavy ordnance, army accouments, iron-clads, &c. But owing to the irregularity with which the rmation and data respecting the several exhibits were obtained, re arose, in certain cases, a necessity to depart in some degree from strict order of classification. The undersigned, feeling it to be their y to notice (though not on exhibition in Paris) any important improvent or event attracting public attention and bearing on the questions ore them, desire to say that some of these cases also, such as the glish trials of the Rodman gun at Shoeburyness, may appear to be of place, or treated in a manner too desultory, because these events e transpiring while this report was being written.

Iuch, indeed nearly all, that has been said about our 15-inch smoothe gun, was written before the trial against the 8-inch Warrior target, h 100-pound charges, which fairly established the superiority of erican ordnance. It is a source of much gratification to the under-

signed to find that these experiments fully corroborate the conclusions previously arrived at by their own investigations as to the high position taken by our country in all that relates to modern gunnery. A single shot from this gun not only saves many of the following pages from being consigned to the waste-basket, but acts like a spell on the English press at whose suggestion the shot was fired. One of the leading journals, after the first trial with 60-pound charges, said: "From the spectacle of this cast-iron leviathan heaving its clumsy shot against the 8-inch target, at a distance of 70 yards, utterly unable to penetrate the inner shield, we turn to the contemplation of our 9-inch Woolwich gun, penetrating the same target, at a range of 250 yards." But after the second trial, with 100-pound charges, we find the same journal saying: "We must frankly admit that we have ourselves, in common with all experienced artillerists of this country, somewhat underrated the powers of the American ordnance. We did not think that the gun would have achieved this success. * * * In the next place we doubted the gun's capability of burning so large a charge of powder before the shot left the muzzle, which capability is now fairly established; and finally, we thought it probable that the cast-iron shot, which the Americans employ, would break up. In this too we were mistaken, and the penetration is a *fait accompli.*" *The Times*, to palliate the defeat of the target, says: "It must not be forgotten that the target had been struck, on previous occasions, by more than 11,000 pounds of iron propelled by about 1,900 pounds of gunpowder." But the writer himself seems to forget that he is suggesting a most powerful argument against their own ordnance, the American gun having done more damage with one round than the Woolwich guns did with fifty. The 11,000 pounds of iron and 1,900 pounds of powder, used in these guns, merely made a few small round holes not impossible to stop up, which (with the exception, perhaps, of a few men killed and wounded) would leave the ship in fair fighting condition; but a twentieth part of the powder and iron, when fired from the 15-inch Rodman, made a hole which no ingenuity could possibly stop, and which, in action, would certainly lead to the surrender or destruction of any vessel so protected.

CHARLES B. NORTON.
WM. J. VALENTINE.

PARIS, 1867.

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CHAPTER I.

CARTRIDGES.

)E OF METALLIC CARTRIDGE—AMERICAN CARTRIDGE—BOXER CARTRIDGE—CHASSE-POT CARTRIDGE—NEEDLE GUN CARTRIDGE—REMARKS ON CARTRIDGES—DAVIS CAR-TRIDGE.

METALLIC CARTRIDGES.

Before adverting to the various systems of breech-loading rifles, it will ; necessary to refer to the cartridge, for, in truth, most of the rifles :hibited have been invented to suit the cartridge, instead of the car-idge being devised to suit the rifle. A cartridge containing the means ' its own ignition is, by no means, a recent discovery, for such a car-idge was patented as early as 1831, and in 1836 a Parisian gunmaker ıtroduced the metallic cartridge, which, with certain modifications, is ı general use at present for smooth-bore sporting arms. The needle-gun ırtridge has been in use in the Prussian service many years, and though ɔt metallic, it contains its own ignition. But the metallic cartridge for eapons of war was first largely adopted in our own armies during the :bellion, and was, as already hinted, the parent of many beautiful ıventions in breech-loading small arms, both in our own and other coun-ıes. In order to compare this with other cartridges, a brief description ill be necessary, and for a comparative description of several of the :st-known cartridges we are chiefly indebted to a paper read by Cap-ıin O'Hea, before the Society of Arts in London.

THE AMERICAN CARTRIDGE.

The American is a simple, metallic cartridge consisting of four parts, ımely, the shell, the fulminate, the charge of gunpowder, and the bullet. he shell is formed from one piece of soft copper—is without joining or elding of any kind, being punched or plugged out from the solid metal y machinery, and is, as nearly as possible, of equal substance or thick-:ss throughout, for the purpose of equal expansion. The means of ;nition is in the shell, round the rim at the base, and when loaded with ıe charge of gunpowder, this shell is made to grip the projectile so as) unite it with the gunpowder and fulminate in one compact body. The rojectile is solid and composed altogether of lead. In addition to the

small number of its component parts, this cartridge has much to recommend it. It is impervious to moisture, and may even be used after immersion in water. It is gas-tight, for the shell expanding with the combustion of the charge, combined with the resistance offered by the initial movement of the bullet, completely seals the breech, and thus effectually prevents the escape of gas-breechwards. It has the additional advantage, that the copper shell can be reformed and reloaded after the contents have been discharged. The original shape of this cartridge case was cylindrical, with a projection at the base for the fulminate, and to help the extraction of the expanded shell; but some modifications have been brought into use with particular arms, among which may be mentioned the invention of General Roberts. The peculiarity of this cartridge is, that the cylindrical portion of it, which is larger than the bore of the arm, extends into the barrel but a short distance, when the diameter of the chamber, as well as of the shell, lessens slightly, until the latter joins the bullet. This facilitates the extraction of the expanded shell, causes more even expansion, and enables the cartridge to contain a somewhat increased charge of powder.

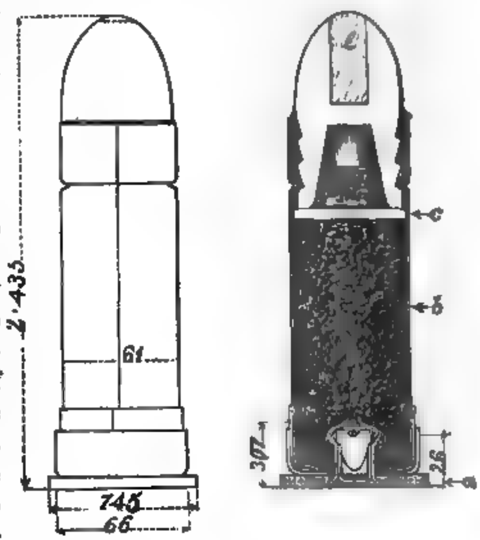
"The Peabody, Cochran, and Hammond rifles," says Captain O'Hea, "are the only American breech-loaders I have seen using a metallic cartridge, with a charge of 55 or 60 grains of powder. However, this fault in the American cartridge could easily be rectified. Another peculiarity of American arms using the metallic cartridge is, that the diameter across the base of the projectile used is always greater than that of the bore of the rifle, measuring from land to land, or the raised portion of the rifling.

"Polygonal rifles, such as the Whitworth, are not used in the United States, consequently the bullet is forced to take the grooving as it passes through the barrel. This has its advantages. It is impossible the bullet can strip, avoid taking or leaving the grooves, and I have seldom heard of fractures."

THE BOXER CARTRIDGE.

The Boxer cartridge for the Snider rifle is a compound metallic cartridge, for though, like the American, it consists of but four parts, the shell, the fulminate, the charge of powder, and the projectile, some of those parts are compound in themselves, so that, in truth, it consists of 14 parts, some of which are doubtless unnecessary. The shell, or cartridge-case, is of two distinct kinds of metal—brass and copper, and in three distinct parts, namely, the base, the coil-shell, and the cap for fulminate; and the projectile is composed of lead, wood, and clay; wood for the centre of the bullet, and clay for the expanding plug. The cylindrical portion of the cartridge-case is formed of a little over two turns of very thin sheet-brass, which is supposed to be expanded, or rather slightly uncoiled, by the explosion, thereby avoiding the danger of fracture of metal by expansion, and of consequent gas escape, even though the cartridge be used in a chamber somewhat larger than its diameter. The

the cartridge was originally of thin sheet-brass, which was put
r brass of much greater thickness than the cylindrical portion to
t was welded or soldered, and it had a projection to stop its enter-
far into the barrel, as well as to facilitate its extraction. The
ion at the base with the thin sheet was sometimes so great, that
found impossible, by the ordinary method, to extract the empty
ge-case; hence the change to a thicker base, also of brass, which
w given place to a base of iron. The weight of the cartridge
t the powder is now about 200 grains. It has, therefore, been
ry to reduce the weight of the bullet at the expense of the utility
weapon, and the secret of the conflicting reports made to the
of Commons on the efficiency of this cartridge is, that in the sev-
als a continual change of cartridge has been made—the powder
ll charge being constantly varied. This cartridge now consists of
n base *a* and the brass shell *b*, as shown in the woodcut. As the
hell is not soldered to
base, a pasteboard wad
ds the cap and fits to
tom to prevent the es-
f gas, and between the
and the bullet there is
wad of cotton-wool *c*.
entre of the base piece
a cap of copper, which
s the means of igniting
rge, and from which the
ge derives its name, cen-
. For the purpose of
g in the new projectile
gh decreased in weight
s) the length and figure
ld, as also with a view to
he greater weight as far
ible from the centre of



Boxer cartridge.

n, the bullet has a picket of wood *e* running through its centre, half-
m the apex of the cone towards the base. At the base is a cavity
ing an expanding plug of baked earth *d*, which latter is also in-
as a support to the sides after expansion. As was a necessity
e old muzzle-loaders, the bullet for the present breech-loading
still made smaller than the bore, and depends for expansion into
oves on the plug of baked clay at the base. The cartridge is
l with a paper covering, attached by gum to protect it from

We are not aware that this cartridge-case can be re-primed and
d after being once used. The charge of powder is 75 grains,
e weight of 60 rounds is about six pounds ten ounces. With
ce to the efficiency of this cartridge, we give the report of C. Hay,

the inspector-general of musketry, February 15, 1867, which wa by order of Parliament, on the 22d of February last, and is as

"SIR: In obedience to the instructions contained in your lett 29th ultimo, I have made a trial of the 'central-fire ball cartridg up with a shorter, or 480 grains bullet, called 'pattern No. 3,' Snider breech-loading long rifle, and have now the honor to r the information of His Royal Highness the Field Marshal comı in-chief, that the shooting at 600 yards is equal to, and at 8 better, than that of the muzzle-loading long Enfield rifle, patt with ordinary ammunition, vide table as per margin. I would however, that the angle of elevation with the Snider rifle is cons greater, at both distances, than the Enfield rifle, pattern 1853, a the bullet is fifty grains lighter. I need hardly observe, that w curve of the trajectory is considerably increased, (a serious de military arm,) the penetration, owing to the decrease of the mo of bullets, must be considerably less than with the ordinary loading ammunition. In several instances the cartridge-case st and could not be removed without the ramrod. The rifle fouled erably, and in one or two instances there was a slight escape which did not, however, interfere with the working of the bree I have no doubt that these defects will be easily overcome v process of manufacture is better understood. The weather l very unsettled, hence the delay in making the trial in question report consequent thereon."

Though some of the defects of this cartridge have been overco the date of the above report, it seems strange that the British ment should persevere at great expense in endeavoring to impro faulty cartridge,[1] when a superior article is already in the mar suitable to the regulation arm. We allude to the cartridge lately i by Mr. Daw, of London, a compound cartridge, and which, recent inventions, is worthy of special mention, as containing so liarities of novel and ingenious description. The cartridge is c of four parts, two of which are compound. The bullet, as in th has the wooden picket through half its longer axis, and the clay the base for expansion. The shell is also of brass, and in thr

[1] Lord Bury narrowly escaped being killed by the explosion of a Boxer cartri recently. He says: "At the first shot the rifle exploded at the breech, blowing covering of the breech and twisting the internal works. I found myself on t bleeding profusely and the cartilage of my nose broken. * * * * From the a of the cartridge it is evident that the primary cause of the accident is the bursti metal base of the cartridge." In one of Colonel Boxer's latest Patent Specification "In the arrangement heretofore employed, the anvil has been made of such a f the cartridge was subjected to a sufficiently sharp blow it could pass, more or les into the percussion cap, so as to strike against the fulminating compound, and th the cartridge." The improvements introduced in this patent were intended to cur other defects of the cartridge, but the accident to Lord Bury, and the recent fatal in the cartridge factory at Woolwich, show that the Boxer cartridge is still very d *to those* who have to handle it.

retaining the copper cap for the fulminate in the centre of the base. In almost all other respects this cartridge differs materially from the Boxer. It is much shorter than the present service cartridge, and the inventor consequently claims for it greater facility of extraction from the regulation arm. The cylindrical portion of the case is composed of a little over one fold of thin metal, which, being united, is perfectly gas-tight, and, from the slightness of this one fold, of little or no weight, and of great flexibility and toughness. The latter is a marked advantage over stouter metal, as the case, on the ignition of the charge, cannot fail to take the form of the breech, or chamber, in which it is enclosed, and cannot impede, in the least, the extraction of the shell after the explosion, as the sudden alteration of the temperature, after the gas leaves the barrel, causes a slight contraction of the metallic shell. It is waterproof as well as gas-tight, requiring no paper covering or lubrication, as, in addition to the shell being joined by cement or solder, it grips the bullet closely above the cannelures, or grooves, and thus the projectile, with the powder and fulminate, are held together in one compact body by the slight shell. The weight of sixty rounds of this cartridge is five pounds eleven ounces, the weight of bullet 465 grains, that of shell and fulminate 105 grains, and the charge of gunpowder is 65 grains.

PAPER CARTRIDGES.

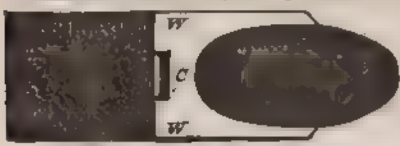
THE CHASSEPOT CARTRIDGE.

The Chassepot cartridge is not, correctly speaking, a metallic cartridge. As described in the specification, it consists of six parts, namely, the priming, the powder-case, the powder, the pasteboard wad, the ball-case, and the ball. The priming consists of a copper cap, like the ordinary military percussion cap, but of smaller dimensions. It is formed at the bottom with two holes, diametrically opposite each other, intended to give free passage to the charge of powder for the spark or flash, the fulminating powder being placed at the bottom of this cap; a small plug of cloth or wax covers it, so as to protect it from external concussion. The cap is then covered with a thin washer of brass, copper, or other metal, which is pasted upon or attached to paper for forming the base of the cartridge, and the priming is thus complete. The powder-case is formed from a rectangular piece of paper, rolled upon a mandril, and pasted at the edges. When the case is dry the priming is inserted with a mandril, and the end of the case is then closed and pasted. The case being thus prepared, the charge of powder is inserted, and is pushed down gently to give rigidity to the cartridge. A pasteboard wad is next placed on the powder, formed with a hole, into which the twisted end of the paper of the case is inserted, the excess of paper being cut off. The ball-case is composed of a paper jacket, having two folds of paper pasted and closed at one end only. The ball is of an elongated tapered form, with a flange at the base. After placing the ball in its case, this case is con-

nected to the powder-case by a string or thread passed round a groove on each case a slight distance behind the wad. Finally, the cartridge is greased.

THE PRUSSIAN NEEDLE-GUN CARTRIDGE.

The cartridge of the *Zündnadelgewehr*, or Prussian needle-gun, is pecu- liarly its own; made for this gun, it can only be used in it, or in a gu having a needle arrangement to reach the fulminate through the powde It consists mainly of four parts, not enclosed in a metallic, but a pap cover. These parts are the powder, the fulminating cap, the carrier-wa and the bullet. The latter is of an acorn shape, and weighs about a ounce, and the charge of powder is 76 grains. The distinguishing featu of this cartridge, as will be seen b the annexed woodcut, are the carri wad *w* and the cap *c*. The carrier-wa is formed of strips of paper, mould into the proper shape by heavy pre



The needle-gun cartridge.

sure, and its uses are as follows: It holds the cap *c*, containing th fulminating compound, protecting it from chemical influence or oth injury; it receives the first impulse of the explosion and transmits it t the bullet, thereby economizing the force of the powder; it is compress into the grooves of the rifling and thus imparts a rotary motion to th bullet, which does not itself touch the barrel, and hence the groov never get clogged with lead; finally, it cleanses the barrel at every di charge of the gun. The wad accompanies the bullet through some 50 o 60 yards of its flight, and about 20 yards from the gun it strikes a targ about three or four inches below the bullet-mark, and at this distan will pierce a pine board of over half an inch in thickness, so that, a short range, the gun may be said to carry two projectiles. This, ho ever, may not always be an advantage, as in the case of firing over a li of troops, at some distance in front, the wad might kill or wound a frie instead of a foe. The fulminate of the needle-gun cartridge was at o time believed to be kept a secret, but it is now generally known to cons of a mixture of chlorate of potash, antimony and sulphur, in the propo tions of five to three, to two of the respective chemicals. As alrea stated, the cartridge is enveloped in a paper case; this case is almost, not entirely, consumed by the combustion of the powder, and, to insu its complete consumption, a certain amount of air is provided for by t air-chamber, or cavity, surrounding the fore part of the needle gui hence there is no empty cartridge to take out of the gun before reloadi The ignition of the powder from the front is, however, the great featu in the needle-gun, as by this means it is all consumed and rende effective. But whether this method possesses sufficient advantages ov the central-fire, or rim fulminate, to counterbalance the disadvanta attending the delicate and complicated mechanism of the needle-gu

will be better appreciated after the several guns themselves have been contrasted or compared. As to the comparative merits of central-fire and rim-ignition cartridges, though the former may, in theory, possess some advantages over the latter, yet there are weighty reasons and arguments against the use of the central-fire system specially applicable to the United States, where magazine arms, such as the Spencer, abound. These cartridges cannot with safety be used in magazine arms, if, as at present, they carry a conical projectile, the point of which, in loading, would impinge on and ignite the cartridge in front while in the magazine.

There are many cartridges in the Exhibition which possess some peculiarity or novelty to recommend them, but to give even a brief description of each would exceed the limits of a report of this nature; besides, though these inventions may each possess one or two features of interest, the cartridge must be looked at as a whole, and those have been selected for illustration which experience has proved to combine the most advantages.

REMARKS ON CARTRIDGES.

Captain O'Hea, in concluding his interesting remarks on cartridges, says:

"In the metallic, there appear to me in addition to the great essential of a sufficient charge of powder for the diameter and length of the bore and weight of projectile, five other requisites for insuring a favorable result, or return, in the use of the metallic cartridge:

"1st. That the shell or case be made of such description, or substance, as will insure its expanding or contracting, but not fracturing. 2d. That the shell be formed of one piece if of soft metal, and of one fold if of harder or medium metal, and that it be gas-tight, limited as to power of and space for expansion. 3d. That the expansion of different metals being unequal, the insertion in any part of the shell of any foreign piece of metal, or even of a distinct piece of metal of the same kind, be avoided as tending to weaken or fracture it, and increase the cost of manufacture; the fulminate ought also to be placed somewhere on the inner surface at the base of the shell, no matter how that surface may be modelled. 4th. That the shell grip the bullet, so that the cartridge may be impervious to moisture, and that the expansion of the shell may be compulsory or inevitable on the expulsion of the bullet. 5th. That the base of the projectile be of such a diameter that it is not only forced to take the grooves as it enters the rifled portion of the barrel, but that all chance of gas escape round the bullet is impossible, and that the latter contains no foreign substance or body that would make it liable to fracture on being driven into the bore, or make the manufacture of it complicated or difficult under any circumstances."

These requisites, with the exception of a "sufficient charge of powder" —a defect easily remedied—are all combined in the American cartridge

already referred to. The very thin cylindrical case of Mr. I tridge[1] possesses some advantages over the heavier shell of the A but Mr. Daw's is a central-fire cartridge, and therefore unsuite azine arms. Like the Boxer, it is uncertain whether it can l after firing, an advantage possessed by the American cartridg combined with its simplicity and cheapness, gives it, in our op first place among the many cartridges that have come under (vation.

[1] The Small-arms Committee have (March, 1868) awarded Mr. Daw the first pı for his cartridges.

CHAPTER II.

BREECH-LOADING SMALL-ARMS

NEEDLE-GUN—SPENCER RIFLE—BALL AND LAMSON'S RIFLE—SNIDER RIFLE—VIENNA RIFLE COMPETITION—REMINGTON RIFLE—PEABODY RIFLE—RIFLE COMPETITION IN ENGLAND—ALBINI AND BRAEDLIN GUN—BURTON GUN—BERDAN RIFLE—HENRY RIFLE—HAMMOND RIFLE—MARTINI RIFLE—SHARP'S RIFLE—SUCCESSFUL COMPETITORS—TABLE OF PROMINENT RIFLES—CHASSEPOT RIFLE—FRENCH BREECH-LOADERS—ELECTRIC GUN—JONES'S RIFLE—SUMMARY.

THE PRUSSIAN NEEDLE-GUN.

The Prussian *Zündnadelgewehr*, or needle-gun, is on several grounds entitled to the precedence in any notice of breech-loading fire-arms. First, because it has for upwards of twenty years been the regular arm of a great European power; secondly, on account of the important part which it played in the late war with Austria; and finally, because, unlike breech-loaders generally, it possesses a peculiar mechanical arrangement, and was not invented to suit some particular cartridge previously in use for other arms. The needle-gun is not exhibited by the Prussian government, but is included among the arms of several private makers of France and other countries.

It is generally believed that the success of this weapon in the late war was due to the fact of its being a breech-loader, rather than to any virtue dependent on the feature of its construction from which it derives its name, and perhaps any other good breech-loader would have had an equal advantage over the muzzle-loading arm, with which the opposing army was furnished. Besides, the needle-gun was not a novelty to the Prussian soldier, 60,000 of these guns, on an improved plan, having cast-steel barrels, were served out as early as 1841, a hundred men of every battalion of the line being equipped with them, and the use of the gun by the Prussian infantry became general about 1848.

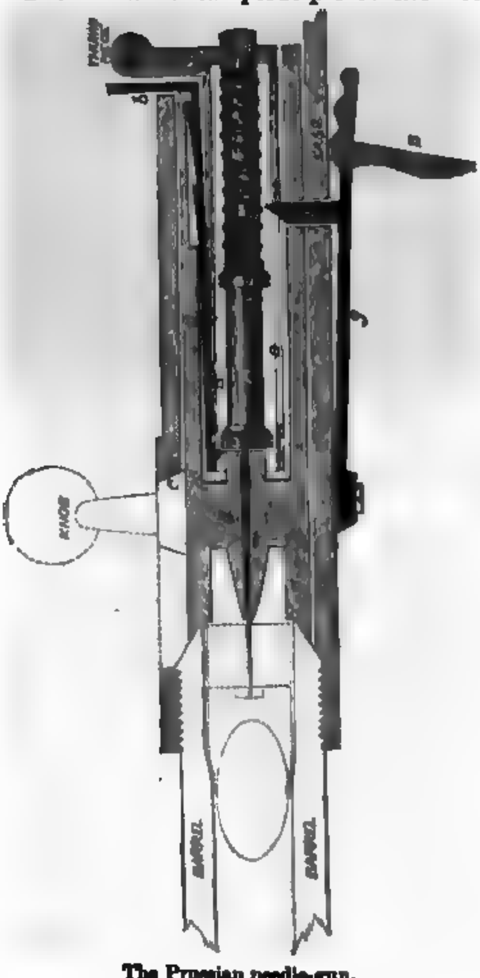
The factories of Spandau, Sömmerada, Erfurt and Danzig, can produce over 100,000 guns annually, and the number possessed by Prussia before the war amounted to 600,000. The royal decree justifying the adoption of the needle-gun came from a King who had served a good apprenticeship to the military art, and contained the following passage, which, read in the light afforded by the late war with Austria, seems to have a prophetic import:

"The rifled needle-gun is, according to our present conviction, the perfection of military arms, and its practical introduction will, no doubt,

lead to its adoption in all branches of the service. The result of ous experiments made us appreciate this invention as a special di tion of Providence for the strengthening of our national resourc we cherish the hope that the system may be kept secret, until th part which it is destined to play in history may couple it with th of Prussian arms and the extension of empire."

The following description of the mechanism of the needle abridged from a paper in an English periodical, *Once a Week*, been verified by examinations of the weapon, as exhibited by the makers in the Exhibition:

The fundamental principle of the needle-gun, as already stat in this: that a cartridg ployed which contains itself the fulminatin pound that is to ignite t der, and since this fu lies buried between the and the bullet, it can reached and struck, an ignited, by a needle the cartridge. The p features of the mechan as follows: first, (be with the feature mos rious,) the needle, fix holder or belt, encircl spiral spring, the re which is to dart the into the explosive second, the lock, or ap for drawing the needle put it into connection w trigger; third, the ch which forms the breec and which carries a litt or guide, through wh needle passes to the ca The whole of this mec is carried in a cylindric which is fixed to the s bands, and into which t rel is screwed, so that



The Prussian needle-gun.

forms, as it were, a prolongation of the barrel; lastly, there is the which, when pulled, discharges the needle from its detaining catc these various parts are disposed, and what is their action, will, we

made clear by the accompanying diagram and the following description. The illustration shows the position of the parts at the moment of firing, just as the needle has struck the fulminate. A is the needle-bolt carrying the needle, and furnished with two shoulders or projections, *a* and *á*, the hinder part passing through the spiral spring.

BB is the lock for drawing the needle-bolt back; it is in the form of a little tube with a projecting thumb-piece at one end, and a little tooth or catch (catching the projection *á* of the needle-bolt) at the other; it is, moreover, held in its place by the locking spring *b*, but can be drawn back when *b* is pressed down.

CC is the chamber, also tubular, in which is fixed the needle-guide *d*. This chamber slides backwards and forwards in the outer case, by an action precisely similar to a street-door bolt, and it is furnished on the outside with a knob or handle by which to move it, bolt-fashion, a slot (not shown in the sectional drawing) being cut lengthwise in it to allow it to pass the catch *h*. Its bevelled or conical end exactly fits the corresponding bevelled or conical end of the barrel, and it is forced into close contact with the latter by a sidewise motion of the knob, (bolt fashion again,) which motion, by thrusting the base of the knob *c* against the slightly inclined edge *f* of a slot in the outer case, jams the two bevelled surfaces together, and thus tightly closes the breech.

D is the trigger acting upon the spring *g*, and thus upon the catch *h*. It will be seen that the upper surface of the trigger's horizontal arm takes its purchase against the under side of the case and that it is furnished with three knuckles or points of pressure; and it will easily be understood that, according as either of these are pressed against the case, (by pull upon the trigger,) so will the catch *h* be drawn down to a greater distance. The first one is in bearing when the gun is out of use, or immediately after firing; when the second or middle one is brought to bear, the catch *h* is drawn down sufficiently to allow the needle-bolt shoulder *a* to pass over it; when the third is brought to bear, *h* is so far withdrawn that the whole of the lock-tube BB will pass over it, so that a soldier can, if necessary, disable his gun in a moment; if he has to retreat, leaving his gun behind him, he merely pulls the trigger very hard and draws BB out by the thumb-piece, and he leaves behind him an empty, useless barrel.

These various parts are thus manipulated in the process of loading and firing:

First, the thumb is pressed upon the spring *b*, and by means of the thumb-piece the small lock-tube is drawn back, pulling with it, by means of the little tooth at the opposite end, the needle-bolt, till the shoulder *a* is caught behind the trigger-catch *h*. Then, by pulling the knob a little on one side, and at the same time pushing it towards the butt-end of the stock, the chamber CC, with the needle-guide, is slid back, and a clear space is left in that part of the case which is in our drawing occupied by the needle-guide. Through the opening thus made the cartridge is

inserted into the end of the barrel, as shown by the dotted lines in tl diagram. The chamber is then bolted up again, and the thumb-pie (and so the lock) is pushed forward to its original position. The positi of things is then just as shown, with the exception that the needle-bol and with it the needle, is held back by the shoulder *a* catching again the trigger-detent *h*, the spiral spring being of course compressed or i tension. The gun is then ready for firing, the trigger is pulled, *h* i drawn down, and the spring, released, darts the needle through th guide into the cartridge, the blunt end of the needle sharply striking th fulminate and thus igniting the charge.

The barrel of the gun is, in the latest pattern, 32 inches long and si tenths of an inch bore, the breech end being widened out to admit th cartridge easily; and it is rifled with four grooves, three-hundredths o an inch deep, the rifling taking one turn in 28½ inches. The total weigh of the gun, without the sword-bayonet, is 10¾ pounds.

The advantages claimed for the needle-gun are chiefly these: That th bullet is propelled through rifled grooves without violent forcing int the barrel—indeed, without coming into contact with it; that the loadin is simple and rapid, the ball, powder, and cap being contained in th cartridge; that the loading is from the breech; that the combustion (the powder and cartridge-case is more complete than in any oth guns; that the escaping gas carries but little smoke with it; that tl gun is instantly disabled, if necessary. Some of these advantages a of course, common to most breech-loaders; but there is one especial me in the needle-gun that is not so common to other constructions, and tl is the ease with which the mechanism can be made and put togeth Concerning the durability of the gun, it is said that many of the batt ions of Prussian fusiliers are using now the very guns served out in 18

Notwithstanding the many advantages claimed for the needle-gun, a which it has proved itself to possess—at least over the Austrian muz loaders—it seems to make slow progress in other countries, now that principles and mechanism are generally known. This cannot accounted for by supposing that other states have got some satisfact gun of their own; the late rifle competition at Vienna, and the ma rifle trials in Great Britain, our own, and other countries show that various governments, and military men generally, are not satisfied tl the victory of the needle-gun is conclusive, or that a sufficiently relia breech-loader has yet been produced. The chief objections to the need gun are doubtless the danger attending the transportation of its pa cartridge, and the delicacy and complication of its mechanical arran ments. The cartridge, unlike the metallic, does not assist in any w to prevent the escape of gas breechwards, so the junction of t chamber-closer or breech-bolt with the barrel must be a perfect mecha cal fit, like the safety-valve of a steam boiler. If a little sand were get into the joint, an injurious escape of gas would be inevitable, *if the spiral* spring that projects the needle were to come in conta

with salt water, the weapon would speedily become ineffective. At the Vienna trials, the Remington rifle was several times covered with dust and left exposed to the influence of damp all night, without interfering with the action of the gun. The Spencer rifle, also, has not only been covered with sand, but immersed in salt water and left exposed for 24 hours, and the report of General (then Captain) Dyer says, "The rifle was then loaded and fired without difficulty. It was not cleaned during the firing, and it appeared to work as well at the end as at the beginning." The needle-gun, subjected to such treatment, would doubtless be unserviceable without a thorough cleansing, or if worked with wet sand among its movements the perfect fit of the movable part to the barrel would be destroyed. Considered mechanically, the needle-gun seems incapable of standing rough usage for a lengthened period, and the late war with Austria was too brief to set this question at rest. Nevertheless, the important part which it took in great battles, rendered decisive through its agency, and the influence it thus had in shortening the war, will always secure for the needle-gun a careful consideration.

THE SPENCER RIFLE.

The Spencer rifle, exhibited by the Spencer Repeating-rifle Company, of Boston, may next claim attention on account of the important influence it had on the late rebellion. If it has not occupied so prominent or exclusive a position in America as the needle-gun has in Europe, it was not the fault of the weapon itself, but rather because our longer struggle called many competing weapons into the field, several of which would, doubtless, be able to hold their ground against the needle-gun.

Although the Spencer rifle and its capabilities are better known to the War Department and the American public than to the governments and people of Europe, still, in a report in which the arms of other nations will occupy a prominent position, we believe it would be injudicious to pass over, in silence, the efforts made by our own countrymen to bring to a triumphant close one of the most dreadful wars recorded in history. On this war the influence of the Spencer rifle, among new weapons, was of no secondary importance.

This rifle is both a breech-loader and a repeater. Seven cartridges are deposited in a magazine located in the butt of the gun, and are thrown forward to the chamber as required. An ordinarily skilled marksman can discharge the seven loads in twelve seconds, while a platoon of soldiers can fire, with good aim, at the rate of once every three seconds. When the seven charges are fired the magazine can be refilled in about half the time required to ram and cap the single charge of a muzzle-loading musket. It is important in a repeating rifle to locate the magazine so that the reserve cartridges should be protected against all danger of explosion. This has been accomplished in the Spencer rifle by a method that appears to meet the necessity. The magazine has a double sheathing of metal strongly encased in wood, and thus presents almost as for-

midable an obstacle against external force as the barrel it safety results, in part, from the character of the cartridge used copper-cased, and contains in the most compact form the po ball, with the addition of the priming fulminate in the periphe base. This cartridge is not injured by exposure to the air, or submersion in water, as the powder and fulminate are both her sealed. For safety and certainty in magazine arms no other compares with this. Central-fire cartridges with conical p would be dangerous in the Spencer rifle magazine, but it is im to explode the rim-fire cartridges except by a concussion mad hammer, and when that concussion is made, no other cartridge with such unfailing regularity. By a very simple arrangem liability to an explosion before the breech is properly closed is impossible, because the hammer cannot be made to strike the c nor anything impinging thereon, until the parts are properly lo

The rifle has frequently been submitted to the judgment of the most eminent ordnance officers of the army and navy. (now Admiral) Dahlgren had the arm thoroughly tested at the W ton navy yard in June, 1861, and, as the result of his experim report thereon, the department ordered a considerable numb rifles for the naval service. In Captain Dahlgren's minute a his experiments with the rifle, he says, "The mechanism is com strong. The piece was fired five hundred times in successio divided between two mornings. There was but one failure to posed to be due to the absence of fulminate. In every other the operation was complete. The mechanism was not cleaned worked throughout as at first. Not the least foulness on the and very little within. The least time of firing seven rounds seconds."

In the following November a board of military officers report lows: "In firing it is accurate; the range good; the cha smaller than is generally used in small calibres; the cartridges, copper tubes, are less liable to damage. The rifle is simple and in construction, and less liable to get out of order than any othe loading arm now in use."

The following directions for loading, with the accompanying will be sufficient to explain the mechanism of the working parts

With the muzzle of the rifle pointed downward, turn the m lock (13) to the right, withdraw the inner magazine-tube (17) the cartridges into the outer magazine, (16,) ball foremost, to the of seven, then insert the tube, locking it securely in place as fir

The magazine being thus charged, the first cartridge is thrown into the chamber of the barrel by moving the guard-lever (5) do to a stop and immediately drawing it back. The first part of th ment brings down the breech-pin (4) below the chamber of the

and so that its upper curved profile forms part of the same circle as the back of the carrier-block, (3.) The continuation of the movement of the guard-lever causes both the carrier-block and breech-pin to swing back together far enough for the front cartridge to pass over the breech-pin; and the whole of the cartridges being pressed forward by the magazine spring (18) and cartridge-follower, (21,) the front cartridge is made to slip over the breech-pin. When the lever is brought back, the cartridge is pushed forward by the breech-pin into the chamber of the barrel, and the breech-pin is pressed up behind it and is held in place by the breech-pin spring, (26.) The magazine and chamber are thus effectually closed by the carrier-block and breech-pin, and all is ready for firing.

The hammer (7) may remain down during the loading, but should be immediately half-cocked, and kept so while a cartridge remains in the chamber of the barrel, (1,) except when firing. Then full-cock the hammer, pull the trigger, (9,) causing the hammer to strike the percussion-slide, (6,) forcing it against the rim of the cartridge and exploding it.

In the opening movement of the breach, the carrier-block moves the shell-draw (23) and causes it to draw out the discharged shell from the chamber, and in its withdrawal the shell slips over the top of the cartridge-guide, (22,) which is then depressed by its springs, (25.) The same guide aids in conducting the new cartridge to the chamber. This operation is repeated until the seven cartridges are discharged. The magazine is then reloaded as at first.

Though these movements are at first sight somewhat complicated, it is stated that the rifle can be discharged seven times in twelve seconds, and loaded and fired twenty-one times a minute. When it is required to be used as a single-loader, and a full magazine held in reserve for a greater emergency, it is necessary to arrest the downward movement of the guard-lever at about one-third the distance, so as to preclude the first cartridge in the magazine from passing forward, and yet leave sufficient space to remove the exploded, and insert by hand a new, cartridge. If necessary, a movable stop may be placed so as to insure this.

It is of the greatest importance to know how this rifle stood the wear and tear of actual warfare. Some valuable statistics on this point, if not already obtained, could be collected from the officers commanding the several corps that used the weapon, for the advantages of the Spencer and other magazine arms, in the hands of men accustomed to their use, cannot be ignored. Men armed with such guns, and trained to hold their charges in reserve, are not likely ever to cross bayonets with an attacking column, or shrink before any charge of cavalry. The confidence which a reserve of seven rounds inspires would give great steadiness to troops, and prevent the demoralization which often follows a volley when the men have to reload in the face of superior numbers advancing to the charge.

Besides the Spencer, we have seen only one other magazine-gun in the Exhibition—Ball and Lamson's, exhibited by the Windsor Manufacturing

Company, of Windsor, Vermont. This gun carries 15 charges, and has the magazine in the stock under the barrel. The inventor holds that it combines all the advantages of a single-loading gun and a repeater, being used as either with equal facility; and that it may be fired as a repeater 9 times in 11 seconds, and as a single-loader 25 times per minute. The magazine, full of cartridges, may be held in reserve while using the arm as a single-loader. It may also be emptied of cartridges without firing or detaching any of the parts. Another advantage claimed for this arm is its security from danger arising from hasty or careless loading; if one or more cartridges should be put into the magazine wrong end first, it is said that on working the level, every such cartridge would be thrown out by the ejector, without interfering with the working of the gun, or causing the removal of any part of it. It has one other peculiarity—there is no danger of the fixing, from rust or other cause, of either pin or striker, as neither one nor the other is required, the charge being ignited by a blow on the cartridge, direct from the hammer. The weight of the carbine is seven pounds and a half, the calibre is .50, the length of the barrel 22 inches, the charge of powder 45 grains, and the weight of bullet 350 grains.

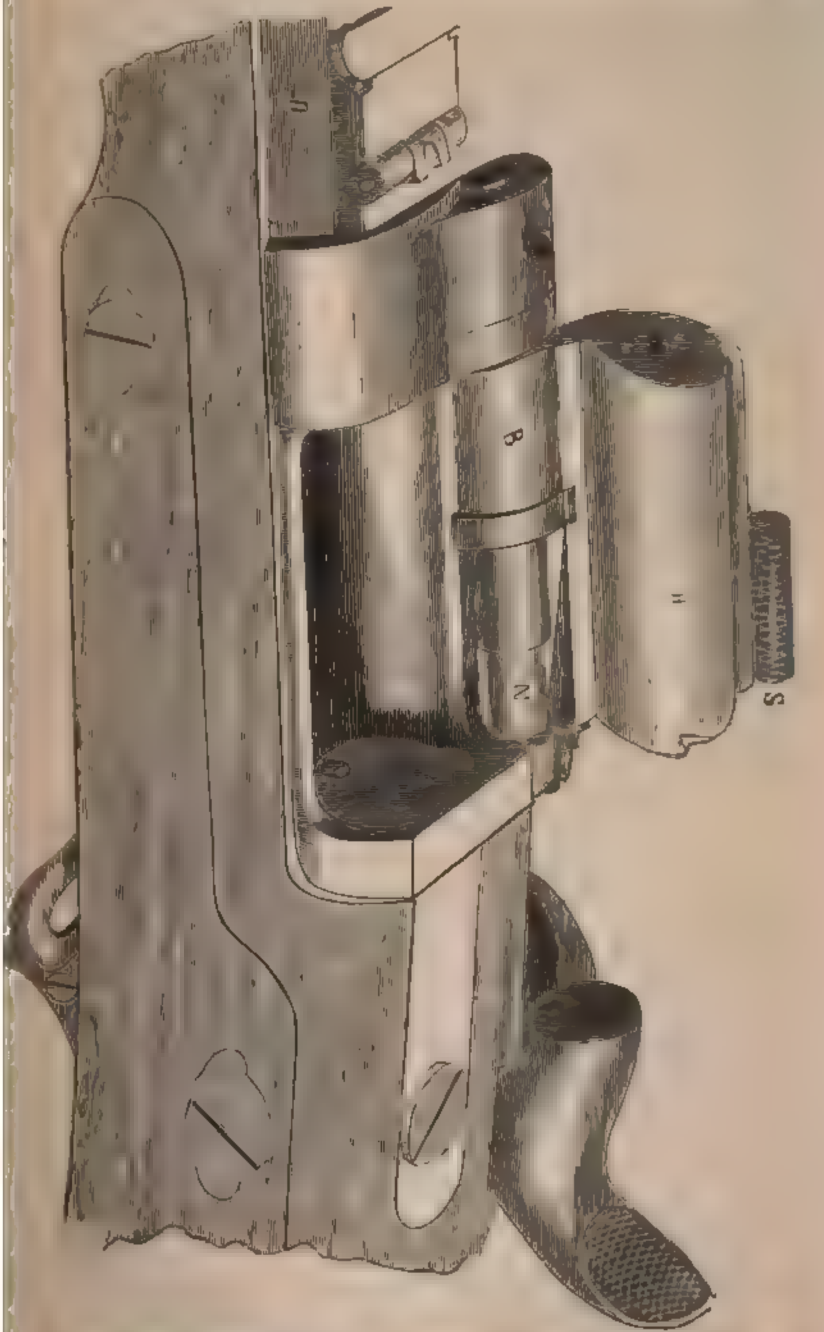
THE SNIDER RIFLE.

The Snider rifle, though it has not yet distinguished itself on the field of battle, has attracted perhaps as much attention as any breech-loader in Europe or America. It is not our intention to enter upon the history of the gun, further than to say that, like other well-known arms adopted by the governments of Europe, it is of American origin. Besides its adoption by the British government, an order for 100,000 has recently been given by the Dutch government.

The Snider system is exhibited by the British government as applied to the long and short Enfield, to the Whitworth, Lancaster, and other rifles that have been adopted into the service. It is also exhibited in the cases of perhaps a dozen of the gun-makers of the different countries exhibiting munitions of war.

The chief feature of the Snider is the breech-closer, a short cylinder or block, nearly the length of the cartridge, which fits into a recess in the rear end of the chamber, and which, by turning up and down upon a hinge on the side of the barrel, opens or closes this recess, for the insertion of extraction of the cartridge. When closed, this breech-cylinder abuts at its rear end against the breech proper of the gun, and at its front end it covers the base of the cartridge. This cylinder, to admit of expansion by heating, can never be a close fit like the needle-gun; hence the Snider depends entirely, for the prevention of gas escape, on the cartridge. In this respect it resembles the American breech-loaders generally, and therefore the faults that have been ascribed to the weapon by various writers belong more properly to the cartridge, as witness the accident to Lord Bury.

he woodcut will sufficiently explain the nature of the breech-block, ylinder. It represents a portion of the rifle showing the end of the



al D and the breech-block H. Here the breech is shown full open, at this point, the thumb on the thumb-piece S having turned the

breech-block into the right hand, the block, hinged on the pin N by the socket B, is drawn smartly back, when the draw-cartridge ejects the empty cartridge-case. According to the "platoon exercise for long and short breech-loading Snider rifle," "to load the Snider," two movements are necessary, one of which is compound, having several motions under the head of one order, namely, that part of the movement detailed at "Three," of the order "Present," and commencing, "Half-cock—open the breech—and holding the breech-block firmly with the forefinger and thumb by means of the thumb-piece and nipple-lump, draw it back as far as possible by a jerk, raising the muzzle of the rifle slightly in doing so, so as to remove the empty cartridge-case; at the same time cant the rifle sharply over to the right to allow the case to fall out, bringing it again to the horizontal position; then carry the right hand to the pouch, and take hold of a cartridge at the rim, with the forefinger and thumb." The cartridge is made so as to slide into the breech without pressing, and with as much play at the rim as to allow the breech-block to shut freely. This is absolutely necessary, because the block has no provision for clearing a passage for itself in the event of the cartridge being too tight or the rim too thick. This loose fit of the cartridge and breech-block has been animadverted on very severely by the English press, which has rendered great service by keeping before Parliament and the public the defects of the gun, until these defects became fully known. "To know the disease is half the cure," and so the Snider rifle, or rather the Boxer cartridge, with the aid of unlimited funds, is creeping slowly out of the difficulty.

The Mechanics' Magazine for March last says that General Peel, then Secretary of State for War, "mentioned Boxer cartridges Nos. 1, 2, and 3, each being of different combinations, for fastening the base to the tube more and more securely. Nos. 1 and 2 have been reported failures. In the mean time millions of these cartridges have been made, at the cost of about £5,000 per million, and cannot be used with safety. If they were given out for service, accidents in the use of the converted Enfield would be frequent and fatal."

The writer is anxious to screen the defects of the cartridge at the expense of the gun, and says "it is apparent that to cover the radical defects of the Snider system, the cartridge is made to bear the sins of the gun." The truth, however, seems to be that the gun, hitherto, has been made to bear the sins of the cartridge; for since a better cartridge has been made than those referred to, the performance of the Snider-Enfield has been highly satisfactory.

"At the Wimbledon meeting this year," says *The Times* of July 19th, "a volunteer, named Andrews, belonging to a Kent corps, and firing with a Snider-Enfield breech-loader at the 500 yards' range, succeeded in firing off no less than 50 shots in the prescribed five minutes; that is to say, exactly 10 a minute. The shots, moreover, instead of being fired off *wildly*, were delivered with steady aim. In the 50 shots he made 46

hits, of which 10 were bull's-eyes, 20 centres, and 15 outers, equivalent n all to a score of 133. At the very same range, not four hours preiously, a competitor had been cheered for making 97, which was then y far the highest score. The astonishing success which had thus been btained with the government weapon became known very speedily all ver the camp, and the council were actually pressed to confer upon ergeant Andrews some special mark of recognition. His score, howver, was eclipsed by the very last shots fired at the 200 yards' stage of he same competition. In the space of three minutes, allowed at this ange, a volunteer, named Oswald, fired 38 shots, or at the rate of nearly 3 a minute, of which 37 were hits. His score consisted of 6 bull'syes, 20 centres, and 11 outers—total, 106."

The credit of these high scores is doubtless due, in a great measure, to he marksman's skill; the fact that such scores can be made with the egulation arm, in so short a time, will go far to acquit the Snider rifle rom the charges of inefficiency that have so frequently been brought gainst it. Besides, it must be remembered that the Snider system, as epresented in the British gun, has not had the advantages of other ystems which begin on a clear foundation; it is merely a converted eapon, and for the purposes of conversion it seems to be well adapted. n the case of the British Enfield, taking everything into consideration, he Snider seems to have made as much of the old materials as could easonably be expected. Before, however, being adopted for new weapons, will probably have to compete with a dozen or so of the best, selected om the 90 odd guns tested at the late "breech-loading rifle competition." n the 25th July the Secretary for War stated, in the House of Comons, that, "216,223 rifles had been at present converted on the Snider ystem, 350,000 would be converted by the end of March next, and they ere now going on at the rate of 1,100 per day."

RIFLE COMPETITION AT VIENNA.

Having referred to the breech-loading rifle competition in Britain, it ay, at this stage of our inquiry, be instrumental in furthering the object f this report to notice, briefly, the several rifles which hitherto have ken a prominent place in the competition, and which will probably be elected for further trials. Before, however, adverting to these English ials, we ought to glance once more at the "rifle competition at Vienna," lready referred to, because the two chief competitors there—Remington nd Peabody—both Americans, also attained an advanced position at e shooting-grounds of Woolwich arsenal. Indeed, at Vienna the const was virtually between these two systems, for though the great numer of the competing breech-loaders comprised some of the most celebrated uropean types, they were found decidedly inferior to either the Remingn or Peabody rifles. With regard to the tests gone through by the o latter guns, the following, from *The Engineer*, is an abstract of the

official report, made by the Archduke William, the president of the commission specially appointed for these trials, to the Emperor of Austria:

RESULTS OF TRIAL OF THE REMINGTON RIFLE.

"The results of the trials made for testing the breech-loading gun of Remington's improved system were as follows:

"The trials of the Remington gun, marked No. 1, had for their principal object the testing of the breech with regard to its adaptation for military purposes, and with regard to its efficiency and durability under the different circumstances occurring in warfare. The trials commenced on the 20th September, 1866. The gun fired 60 rounds with the heaviest charges present—that is, containing 75 grains of English powder, 40 rounds with cartridges of 60 grains of powder, against a target 300 yards distant, and 40 rounds with 60 grains of powder, fired for rapidity. With these 140 rounds there was no fault of any kind. The breech acted perfectly; the accuracy, as shown by the target, (Fig. 1,) was found very good, and in firing for rapidity, 13 shots were fired per minute. The gun, having been taken apart after this trial, showed no signs of wear in any part of its breech. It was put together without cleaning of any of its parts, and preserved for further trial.

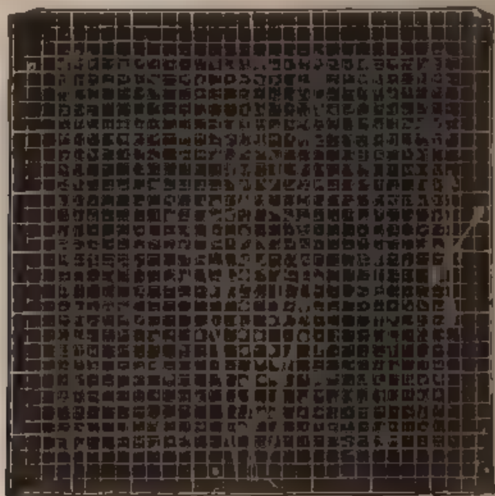


Fig 1

"Second trial, September 21, 1866. The firing for testing the durability of the breech was continued with cartridges of 60 grains.

"Eighty rounds were fired in one continuous series. One cartridge split lengthways without causing any difficulty in opening the breech and without covering the latter with dirt. The barrel having then been cooled by cold water poured through it, a further number of 30 rounds were fired, after which cartridges of 45 grains were used, with which 100 shots were fired. The barrel was cooled after each series of rounds, by

uning cold water through it; and at last, after having fired 414 rounds, whole gun, including the breech, was made wet, and left in that state, ascertain the influence of rust upon the working parts.

'Third trial, 22d September, 1866. The gun, left in a wet state on the vious day, was taken apart and examined. All parts of the breech l lock were thickly coated with rust, but the working of the breech s not interfered with. The gun was put together without cleaning, l the trials continued in that state, in order to establish the influence ust, covering the breech and lock, upon the firing of the gun.

It was decided to fire 2,000 rounds in all with this gun. Of these, rounds were fired to measure the force of recoil in a special apparatus. e mean recoil was 48 pounds.

Thirty-two rounds for rapidity, without taking aim, were made by an ert shot in one minute 52 seconds, giving 17 shots per minute. Thirty-r shots were fired in succession, after having covered the whole breech h road dust, and 50 rounds after that, without any difficulty occurring. The gun was thereupon covered with dust again, and left exposed to influence of damp air during one night. On the 28th September, 6, the gun was examined, and it was found impossible to set the ham-r at full cock. Having been taken apart, it was found that some sand l lodged itself between the breech-piece and the spring acting upon it, ich caused the above-named obstruction. After removal of this sand, without any further cleaning of the breech, the gun was put together, l its action was again perfect.

'The trials were continued. Ten cartridges, which had been previously pt under water for a quarter an hour, were fired without missing, and ht were fired at a wooden box filled with cartridges. The eighth shot the box and entered through its side. Of the 260 cartridges contained the box, five were exploded, and the lid of the box thrown off thereby. the rest, 10 cartridges were squeezed in and spoiled; 26 were black-ed outside; all the rest remained intact.

"After completing the number of 2,000 rounds, seven cartridges, having eir ends purposely filed through and cut in different places, were fired, order to ascertain the effect of the escaping gases upon the breech, in se of bursting of cartridges. The gun was for that purpose inserted a rest. Five of the cartridges burst open, and an escape of flame was served at the breech, but the latter was not injured or thrown open.

'The final examination of all parts showed no perceptible wear of any the parts of the breech and lock, the same having retained their orig-l solidity and freedom of movement.

RESULTS OF TRIAL OF THE PEABODY RIFLE.

'The results of the trials with the breech-loading arm, 'System Pea-ly,' were as follows:

'The firing for accuracy in the first series was commenced on the 18th September, 1866, and consisted of 32 shots at a target, distance 300 ds; 30 shots at a *target, distance* 600 yards.

"The results obtained are shown in the accompanying diagram
target, (Fig 2.)

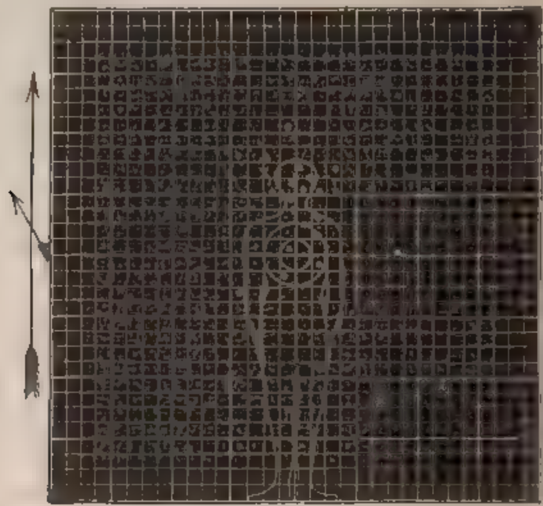


Fig. 2.

"With reference to firing for rapidity, trials were made, both aim
from a rest, and from the shoulder without a rest.

"In the first manner, 14 shots in one minute were fired, the cartrid
having been placed on a table near the marksman. Of these shots
bullets struck the target, the latter being eight feet square.

"In firing from the shoulder, 32 shots were fired in two minutes.
cartridges in this case were also placed on a table.

"Besides the 108 shots above referred to, the following were fired fr
the Peabody gun solely for the purpose of testing the breech:

24 shots in 1 series on the 18th September.

160 shots in 5 series of 32 rounds on 21st September, 1866.

56 shots in 1 series of 32 rounds on 21st September, 1866.

150 shots in 5 series of 32 rounds on 22d September, 1866.

"The firing in the single series was continued without intermission,
the pauses between the series were only long enough to enable the gu
cool. During these 401 rounds, as well as during the 108 before mentio
or together 509 rounds, the breech operated perfectly well, and had c
pletely retained its easy movement, although the gun had not been clea
during the whole course of the trials. In short, no difficulty or obje
had presented itself during the various series. The breech appar
performed its functions with perfect efficiency, only when loading it w
necessary to insert the cartridge completely into its chamber, as ot
wise the closing of the breech would be impossible, and the cartr
would be liable to be deformed in case the breech piece should be bro
up with a violent motion. Of the 509 shots mentioned, there was
missfire; but this cartridge also exploded after having been slig

ıed in its chamber. The cartridge-cases were not injured by firing, no escape of gas took place. After the fourth day of the trials the was taken apart and examined; some rust was found on the barrel, a deposit from the powder-smoke in some parts of the breech; but easy movement of the breech apparatus was not in any manner ɔted. The gun was now cleaned, and firing with cartridges pur-ɔly injured was commenced, in order to learn the effect upon the ·ch consequent on the bursting of a cartridge-case, and the danger to marksman to be apprehended from the escape of gas. To this end gun was screwed on a rest, and two shots were fired with cartridges ch had been filed and slightly split. The effect of these shots were the base of the cartridge was almost entirely torn off, the gas .ped upwards, downwards, and rearwards, tore and scorched a paper ch had been adjusted over the breech and about four or five inches ı it, and would have seriously injured a marksman. The breech, ever, remained without injury, and was covered only with a small osit of powder-smoke. In measuring the recoil in the measuring aratus, five rounds showed a mean of 41.6 pounds. During the fur- trials, a quantity of dirt was thrown into the breech. After each e the breech opened, with somewhat more difficulty than usual, but he second or third round it recovered its regular easy movement. ing the first series on this day, tests were made to prove whether, if cartridge be inserted while the hammer is down, the cartridge will explode upon closing the breech. This did not take place. It was found admissible, and without danger, to fire the gun at exactly the ıe moment it was closed. The gun, out of which 1,750 shots had now n fired, was again covered with dirt, and exposed to the damp night until the following day for continuing trials, namely, on the 22d of ober, 1866. Upon examining the Peadody gun, which had been left he condition above described, it was found that, although the breech partially covered with rust, and completely clogged with dirt, it was capable of performing its functions, though a somewhat greater e was necessary to operate it. Very satisfactory results as to accu- were obtained. Upon taking the gun apart and examining it, after 2 rounds had been fired, no alteration or injury of any part of the ech could be discovered."

Vith this trial, the tests of the Peabody gun were concluded, and they w that with good cartridges, it has proved itself well adapted for itary service.

DESCRIPTION OF THE REMINGTON RIFLE.

'igs. 1 and 2 are longitudinal sections through the breech of the nington gun. Fig. 1 represents the position of parts after firing; and . 2, when open and ready for loading. The barrel is screwed into the ech-piece, through which pass two strong bolts, *b* and *c*, upon which the ech-block B, and the hammer C, hinge. In order to remove the empty tridge-case out of the *chamber*, which is in the rear end of the barrel,

the hammer must first be locked, the breech-block is th wards, and assumes the position shown in Fig. 2. By of the breech block, an extractor, situated in the inside is operated, which draws the cartridge slightly, whereup be removed with the fingers. The following cartridg inserted, and the breech-block pushed forward to its origin hold it in this position the lever D, acting upon the pin d, turn by the spring e, is applied and falls into a notch in th In the breech block itself is the pin upon which the ham exploding the cartridge, and the hammer is operated by t as shown in the wood cut. As the hammer descends, face, from its peculiar circular construction, collides with of the breech piece, and it also acts as a support in resist of the discharge.

DESCRIPTION OF THE PEABODY RIF

Peabody rifle.

The Peabod sented in secti panying wood breech block pin B; C is th which transmi the hammer and which i small sliding mined in am passed throug O, shown in d order to open trigger guard by which th A is depressed on the lower bow-lever D, empty cartri cocking the a fresh cartr ing up the g gun is again

The result trials was, th ton gun wa for adoption; ly the blowi breech, or dent in the dier, (perhap

the weapon,) combined with several abortive attempts to manufacture cartridge in Austria, delayed the execution of the recommendation. this date, July 31st, it is not known that Austria has decided to adopt particular system, notwithstanding the various reports to the effect tthe "Lindner" rifle has been adopted.[1]

BREECH-LOADING RIFLE COMPETITION IN ENGLAND.

The "breech-loading rifle competition" commenced in England on the h of April last. The prizes offered were, £1,000 for the best gun, and 0 for the second best, whether adopted into the service or not. Over hundred competitors put in an appearance, but many excellent apons, for various reasons, were not eligible for the prizes. It was prising to notice the numerous instances in which the published conions were disregarded. Some guns were too short, others too long, ne too heavy, some unfinished or improved, and many sent in after date named for reception. Though any one of these exceptions to previously arranged terms of the competition would prevent a gun m obtaining a prize, it would not debar it from a fair acknowledgment the special merits of the weapon.

The regulations adopted were, that two rifles at a time should shot for accuracy from two shoulder-rests, one on the right, the ner on the left of the shooting-stand, with a sufficient space of ound between to admit to the committee freely discussing points of rit or information with either inventor, out of hearing of his comtitor. These were then fired in succession for rapidity, and after e record of the practice had been made, two other guns were taken in e same manner. Two targets were placed opposite the rests, and the n taken at either respectively. As the days of trial for particular apons were fixed, letters of invitation to be present were forwarded the inventors. The arms selected for the day's trial were placed in e armory, and no one was allowed access, or was permitted to exame any other than his own particular weapon. Among the guns lected for a final competition for the prizes, the following seem to cupy the foremost rank: The rifle of Major Fosbery, Mr. J. H. Burn, Mr. Henry, and Mr. J. R. Cooper, British inventors; Messrs. Albini d Braedlin's rifle on the Mont Storm principle; those of Mr. Joslyn, r. Peabody, Mr. Remington, and Colonel Berdan, also American, and a n by Mr. Martini, of Switzerland. In considering the descriptions of e above competing rifles, and their trials, it should be borne in mind at the object of the competition was to obtain data for the selection the best systems for new weapons for the service, and that the sysns best adapted for conversions are not, as already suggested, always e best when a new arm has to be produced. So it is not surprising

[1] Since the above was written, the Austrian government, it is said, have adopted the Vandl" breech-loader, but in the mean time are converting their old guns on the "Wanzl" tem. Some Remington rifles have also been ordered.

that the four improved rifles sent to the competition by Colonel Roden, on behalf of the Snider Company, have been beaten by other competing systems. But it must be remembered that the Snider system had to comply with the conditions demanded by the War Department, namely, "that the conversion be effected without any alteration of the stock or lock of the existing muzzle-loading Enfield." These conditions have been complied with, but then there is no doubt whatever as to the liability of the Snider breech-blocks to blow open, whenever there is an escape of gas from damaged cartridges, or that the turning over of the piece after each shot to eject the empty cartridge-case is a clumsy and tiring operation. Hence, it is evident that when a system has to be selected for entirely new weapons, none of these restrictions, incident to conversion, stand in the way of inventors, or the committee appointed to test their guns.

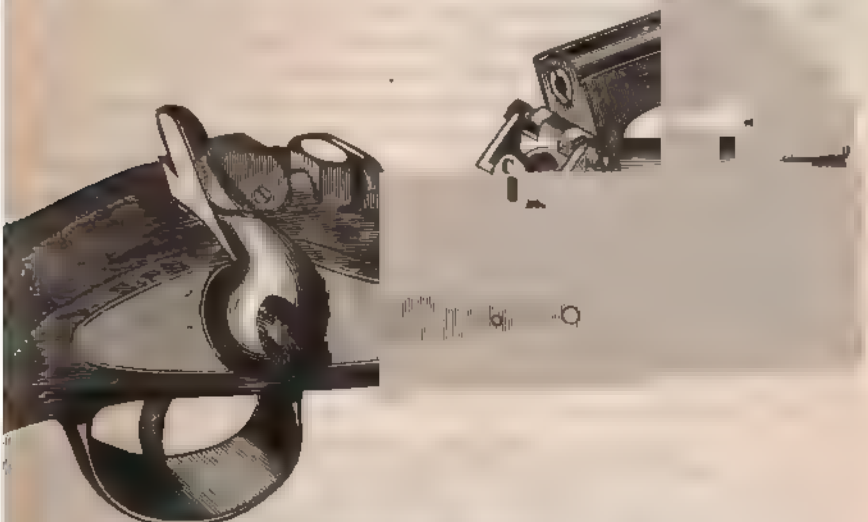
Major Fosbery's rifle is on the Mont Storm principle, which makes six of the ten above-named rifles of American origin. The lock is in the centre of the stock, and the breech-block is designed for central-fire cartridges, but it can be adapted for self-consuming paper cartridges also. The breech-block is hinged in front, and falls over on the barrel. At the side of the breech arrangement, a slide with a straight projecting handle works horizontally. When this is grasped by the right hand, and drawn towards the body of the shooter, the slide acts upon one side of a sort of semicircular curve, attached to the breech-block, and automatically turns it over on the barrel. When the cartridge is inserted, the handle is pushed forward, and the block is brought back again into the chamber and closes it. The same slide works an extractor formed by a rod working horizontally on the right side of the barrel. One action thus opening the chamber and drawing the empty cartridge-case, and another closing the breech after loading.

The explosion-action consists of two pistons, one striking the other in line. One of these secures the breech-block from flying up on the escape of gas from the chamber. Ammunition, service cartridge No. 1; in firing for rapidity 12 rounds in 50 seconds were disposed of by Major Fosbery.

ALBINI AND BRAEDLIN GUN.

The gun of Messrs. Albini and Braedlin is also on the Mont Storm system, calibre 0.462 inch, adapted for central-fire cartridge. Breech arrangement put on as a shoe. The piston or striker passes through the longitudinal axis of the breech-block, and receives the blow of a horizontal bolt worked by the lock. This bolt, in the act of firing, secures the breech-block from being accidentally blown open by any escape of gas. The extractor consists of two simple forks hinged on the pin of the breech-block, a projecting catch on the back of the fork meeting a similar projection on the block, which, in being turned back, acts *as a lever* to extract the empty cartridge-case. Ammunition: special

cartridge, length 3.4 inch; weight, 689 grains; bullet, cylindro-conoidal, with a basal cavity packed with chopped blotting-paper, weight 480 grains; charge of powder, 68 grains. Weight of 60 rounds packed, 6 pounds. For rapidity Mr. Braedlin fired 12 rounds in 1 minute 31 seconds. The cartridges were easily drawn, and neither delay nor accident occurred. It will be seen by a reference to the woodcut that the



Albini and Braedlin gun.

rifle is a combination of the Mont Storm and Snider systems, the arrangement of the extractor being the chief novelty. The breech-block B is here shown open, and the cartridge extractor E in the act of drawing the empty cartridge C. This gun has been adopted by the Belgian government, and by all accounts seems to be giving satisfaction. It possesses one or two improvements on the Snider rifle. For instance, if the cartridge does not go home fully, the breech of the Snider cannot be closed, whilst in the case of the "Braedlin" the mere closing of the breech helps to force the cartridge to its place. Again, the axis of the striker is in a line with the axis of the barrel, and thus the cap in the cartridge, being struck more fairly, stands a better chance of ignition, and the protrusion of the exploded cap cannot, of course, prevent the breech from being opened.

THE BURTON RIFLE.

Mr. Burton's rifle is adapted for central-fire cartridges; calibre 0.577 inch. The breech-block works on a hinge travelling downward through the stock, by means of the leverage of a short trigger guard beneath the gun, until it becomes nearly vertical; the cartridge-case, on extraction, is intended to fall through the slot in the stock to the ground, and if it fail to do so, can be readily thrown out. The extractor is formed to the flat head of a raised band of metal on the circular part of the breech-block over the hinge and its action is, of course, consonant with the

motion of the block in the opening of the chamber. A trigger works a strong catch-plate set in the rear end of the breech, and which, by locking into a corresponding cavity in the stock end of the shoe, prevents any disturbance of the block in the act of firing. Ordinary lock, hammer, and trigger. Ammunition, service cartridge. Mr. Burton fired his 12 rounds in 57 seconds, the most of the empty cases falling through the slot. The breech arrangement worked well.

Mr. Burton had a second rifle somewhat similar in principle to the Prussian needle-gun bolt, with piston adapted for central-fire cartridge calibre 0.577 inch. The bolt slides in the chamber of the shoe in the ordinary manner. On the upper part of the bolt a square block projects, working in a corresponding groove in the inner part of the rear-end metal circle of the shoe. On turning the handle of this bolt sidewise, the end of the projection on the bolt is brought to bear against the face of the chamber-slot in the shoe, and the bolt is fixed in its place.

Rapidity of firing, 12 rounds in 1 minute 2 seconds. Service cartridge.

Burton gun.

The peculiar arrangement of the Burton gun, No. 1, will be better understood by the following description from *The Engineer*, of London, and the above woodcut:

"As may be seen from the drawing, the movable breech-piece is provided at its under side with a handle whereby the breech piece is moved

ı its centre *b*, to open or close the chamber in the barrel. When osed, it shuts against a fixed projection *i*, in the shoe *f*, and is held in s place by a spring-catch, *j*. This catch is actuated or withdrawn by ιe lever or second trigger *g*, which forms part of the catch-piece. The ꜱtions of opening the catch and drawing down the breech-piece are ridently included in the one movement. The extractor for removing ιe empty cartridge case consists of a little cam or projection, *h*, on the rcular boss of the breech-piece, which, in opening the breech, comes to contact with the rim of the empty case, and so forces it out, when drops through the aperture, as shown in the cut. When the new cartridge is inserted, the flange of its base will come against the extracting ud, beyond which it cannot pass until the breech-piece is brought up to its place, which movement will carry the extractor forward, and the ce of the breech-piece will then force home the cartridge, simultaneısly with the closing operation. The cartridge is exploded by means ' a striker somewhat similar in appearance to that in use in the Snider ıd some other guns, but is really very different. There is no spiral ›ring to bring back this striker to its normal position, but on the under de of it, and near its rear end, there is a little projecting stud or tooth, hich bears against a corresponding one on the upper side of the springıtch. Should the breech-piece be imperfectly closed, the gun cannot ɔ fired, as the stud on the catch engages the stud on the exploding pin : striker, and prevents it being driven forward by the hammer; while ι the act of opening the breech, the stud on the catch pushes back the riker to its former position, and thus renders the use of a spiral spring ınecessary. The cartridge for this gun may be either rim-fire or ꜱntral-fire. During the competition the service Boxer cartridge was ɔed."

THE BERDAN RIFLE.

Colonel Berdan's gun, adopted for central-fire cartridges, has a common lock, and a calibre of 0.577 inch. Its other features are a hinged ock throwing over to the front; diagonal piston with spiral spring; ight longitudinal motion of block attached to the barrel upon which ıe breech-block is hinged, to permit, seemingly, of a closer closing ome. In the closing, a short-placed cartridge will be pushed, for disınce of half an inch, home into the chamber. The extractor is formed y a doubly-notched oval plate, pivoted on the hinge pin of the breechlock, and the edge of corresponding slot, in which, in the act of the lock falling back on the barrel in opening, presses against one notched ɔce, and by a corresponding leverage brings forward the other, and ulls out the cartridge-case; stock not cut away. Ammunition, service ırtridge No. 3. Rapidity, 12 rounds in 57 seconds. Breech arrangeıent worked well.

THE COOPER RIFLE.

Mr. Cooper's gun is on the bolt principle, with piston adapted for ꜱntral-fire cartridges. *Calibre 0.463* inch; common lock. Cartridge-

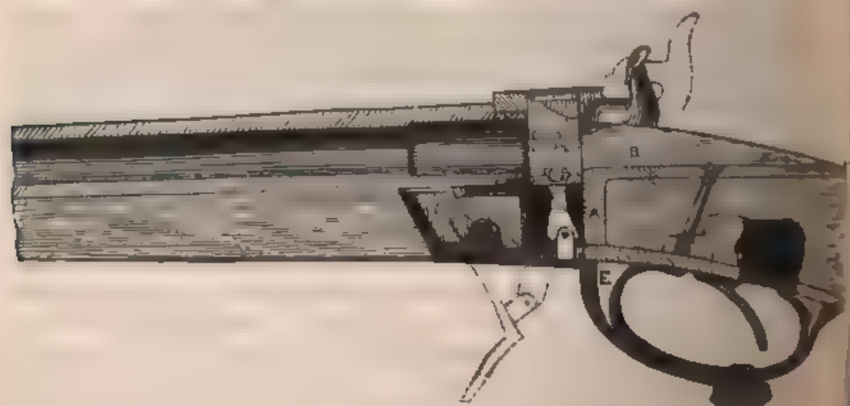
case thrown out by drawing back of bolt, the extractor being attached to upper side of bolt. The piston (with a spiral spring) is struck by the hammer, which, at full cock, lies embedded in the centre of stock. Ammunition, service cartridge No. 2. Breech action worked well, and the 12 rounds were fired in 1 minute 2 seconds. The Cooper rifle is manufactured and exhibited by the Whitworth Company of Manchester. One of its best features seems to be the arrangement of the lock, by which the bolt is capable of being drawn back over it. The hammer, being in the centre of the stock, strikes the detonating pin a fair blow. The blow does not, as in the Chassepot, enter the chamber of the gun, or even touch the end of the barrel. It impinges on the iron base of the cartridge, and the barrel (differing in this respect from the Snider) has no recess to receive it (the base,) but the projecting rim rests on the end of the barrel, consequently the cartridge is never out of sight, and the soldier sees at a glance if his piece is properly loaded.

THE JOSLYN RIFLE.

Mr. Joslyn's rifle, calibre 0.500, has a swinging breech-piece of a peculiar pattern. This piece swings out laterally at right angles to the barrel, this movement being the chief novelty in the gun's construction. A complete description would be very lengthy; suffice it, therefore, to say that the cartridge used is the American rim-fire cartridge, bees' wax lubrication. Weight of 60 rounds packed, 4 pounds 14 ounces. The practice for rapidity at the competition was 12 rounds in 47 seconds.

THE HENRY RIFLE.

The Henry rifle, the invention of Mr. Henry, of Edinburgh, is adapted for central-fire cartridges; calibre 0.577 inch. The breech-block is very short, and works vertically in the shoe, being depressed or elevated by a hinged lever, fitting with a catch over the trigger-guard.



Henry. rifle.

The cartridge is passed into the barrel along an open cutting in the *stock*, and is exploded by a striker passing diagonally through the breech

piece. The face of the breech-block is fitted with a cavity into which the hammer falls. In the accompanying engraving the shoe A is formed with a long strap, by means of which it is united to the stock; the barrel is screwed into this shoe, but it may be made in one piece. The stock and shoe in rear of the barrel are hollowed out, as shown at B, to admit of the cartridge being passed into the barrel. The breech-piece C is jointed, by means of a short link, with the lever E, which on being released from the trigger-guard, and pulled down at the same time, draws the breech-piece into the position shown by the dotted lines in the engraving. At the same time as the breech-piece is drawn down, the inner end of the lever E presses against the extractor and forces it outwards, thus freeing the barrel of the empty cartridge-case. The piston or striker shown in dotted lines in the breech-piece is driven forward by the hammer, and in order that too severe an impulse may not be imparted to the striker, a portion of the hammer is left projecting at the side, which catches against the side of the breech-piece. The practice for rapidity was 12 shots in 49 seconds.

THE HAMMOND RIFLE.

The Hammond gun, of the Hammond Connecticut Arm Manufactory, is different in principle from any of its competitors. It was withdrawn to adapt it to central-fire cartridges, and may therefore not be eligible to compete for the prizes. At the trial the ammunition used was the metallic rim-fire cartridge, length 2.24 inches; weight 530 grains. Bullet, cylindro-conoidal, with flattened point, two cannelures, cavity at base, no plug; length 1.46 inch; diameter 0.468 inch, weight 380 grains, weight of 60 rounds packed, 4 pounds 11 ounces. For rapidity, 12 shots were fired in 1 minute 1 second. The following description and engraving of this gun is from *The Engineer*.

"In the construction of this gun, that part of the arm or frame forming the sole connection between the barrel and the stock, constitutes a bearing or journal for the breech-block to turn upon. The rear portion of the breech-block, and that part of the frame against which this rear portion works, are cam-shaped, or eccentric, and therefore, when the breech-block is swung to the left it has a lateral and oblique rearward motion in order to open the cartridge chamber, and when swung to the right it has an oblique forward motion which helps to force the cartridge to its place and close the breech. In combination with, and worked by, the breech-block, is an ejector for removing the empty cartridge-case. On the under side of the breech-block is a projecting piece, which works in an oblique groove made in the arm of the ejector, which is of the ordinary form. When the breech-block is moved in its seat, the projecting piece *f*, shown in Fig. 4, by moving in the oblique groove *b*, Fig. 6, forces back the ejector, and pushes out the cartridge. The shape of this ejector is seen in Fig. 5. After throwing out the cartridge-case, the ejector is forced back to its position by the spring, Fig. 6, and the

piece is ready for reloading. The nose and heel of the hammer enter into recesses in the block and frame respectively, so as to aid in strengthening the arm against the strain occasioned by firing. The breech block and hammer are also serrated at the points where they would touch each other, when the block is swung open, and the hammer accidentally or otherwise let down against it. The object of this improvement is to prevent an accidental discharge, should the breech-block be closed without cocking the hammer, which would let the hammer fly with such violence against the firing pin as possibly to ignite the charge. In the illustration, Fig. 3 shows a section of the breech-apparatus; H is the thumb-

Hammond rifle.

piece, which, when pressed down, also presses the block *e*, and by turning the breech block G to the left, the projection *f* (Fig. 4) takes the oblique groove *g*, and the head of the locking bolt takes the groove *g'*, Fig. 2, on or in the block to admit of it, and causes this block to move obliquely rearward. By continuing the motion of the breech block, the projection *f* takes the groove *b*, in the ejector, as above explained. In *Fig. 3*, *c* represents the striker, and D the hammer; the recess into

which the hammer falls is shown at *p*, Fig. 2." *The Engineer* adds a foot-note as follows: "We have since ascertained, that as the pattern gun was not fitted with a cleaning rod, and was some ounces heavier than the regulations prescribed, it was debarred from the competition, but it is nevertheless under trial by the commission."

THE MARTINI RIFLE.

The breech-loader of Mr. Martini, of Switzerland, is adapted for rim-fire metallic cartridges; calibre 0.433 inch, breech arrangement as a shoe. The open end of the chamber is closed at the sides, as in the Peabody rifle, the breech-block being also depressed in front in the same manner by the leverage of the movable trigger-guard. If the trigger be pulled while the breech remains open, the trigger-guard and the breech-block fall into place, and the gun is closed up with safety without any explosion of the cartridge. The pulling out of the trigger-guard will then re-cock the piece. The ordinary lock is dispensed with, and the spiral spring within the breech-block drives a piston for striking the cartridge. A detached short piston, working in connection with the lock, acts as a sort of tell-tale, by protruding as a stud when the gun is cocked, and remaining flush when not. The action of this breech arrangement is very attractive. Ammunition-cartridge: length 2.292 inches, weight 620 grains; bullet, cylindro-conoidal, with four cannelures, weight 334 grains; lubrication, white wax, with a quarter part of tallow; charge, 72 grains. Weight of 60 rounds packed, 4 pounds 9 ounces. For accuracy, good; after the eighth round the cartridge-cases drew hard. Rapidity, 12 rounds in 48 seconds.

The Peabody rifle used at the trial was 0.500 inch calibre. Ammunition, copper rim-fire cartridge; length 1.91 inch; weight 530 grains; bullet, cylindro-conoidal, with three cannelures and a cavity at the base; length 0.900 inch, diameter 0.52 inch; weight 395 grains; charge 60 grains. Weight of 60 rounds packed, 4 pounds 10¾ ounces. In practice for rapidity, 12 rounds were fired in 53 seconds.

The Remington rifle was also 0.500 inch calibre. Ammunition, copper cartridge, length 2.22 inches; weight 586 grains. Bullet, cylindro-conoidal, length 0.83 inch; diameter 0.52 inch; weight 407 grains; weight of 60 rounds packed, 5 pounds 2 ounces; practice with central-fire cartridges, for rapidity, 12 rounds in 50 seconds; with rim-fire cartridges, 1 rounds in 40 seconds. In adapting this gun to central-fire cartridges, the breech-block requires to be changed.

SHARP'S RIFLE.

Mr. Sharp's rifle also took a good position at these trials, and has some peculiar features worthy of notice, such as the weight of the specified 0 rounds. It is on the breech-block principle, and the calibre is 0.500 inch. The breech action is confined to three parts, the lever, the slide, and the extractor. The lever forming the trigger-guard opens the breech.

The breech-slide being spheroidal, permits the use of cartridges with varying thickness of base. Ammunition, rim-fire metallic cartridge; length, 1.89 inch; weight, 552 grains; bullet, cylindro-conoidal, with three cannelures and flattened point, solid base, length 0.83 inch; diameter 0.52 inch. Weight 487 grains; wax lubrication; charge of powder 67 grains; weight of 60 rounds packed, 4 pounds 13½ ounces; practice for rapidity, 12 rounds in 51 seconds. Breech arrangement worked well.

SOPER'S AND OTHER RIFLES.

The rifle of Mr. Soper disposed of the 12 rounds in the shortest time—39 seconds—but it is perhaps too complicated to stand the rough usage of the regular military service. The mechanism of the gun is remarkable for its high degree of elaboration. By one operation the breech is opened, the gun cocked, and the discharged case thrown out. The breech is opened and closed by a wedge-block worked by a hinged lever. The lock is central in the stock, and the trigger, mounted on a lever, can be secured at full-cock by a bolt. Ammunition, similar to service cartridge No. 2; length 2.440 inches; weight 765 grains. Bullet weighs 533 grains; charge of powder, 71 grains. Weight of 60 rounds packed, 6 pounds 10½ ounces; practice for rapidity, 12 rounds in 39 seconds; three missfires; accuracy good.

SUCCESSFUL COMPETITORS.

The guns of the Snider company did not, as already stated, take a prominent place at the competition. Two were large bores 0.577 inch: one was 0.500, and the other 0.450 inch. They were all adapted for central-fire cartridges. There was nothing remarkable in the firing, either for accuracy or rapidity. One of the guns (No. 3) struck the target only thrice in 10 rounds. For rapidity the best was the large bore, 12 rounds in 1 minute 10 seconds, and the worst, the smallest bore, 12 rounds in 2 minutes 3 seconds. Some of the cartridges were hard to draw, the base of one broke off, and the ramrod had to be used to extract the empty case. These Snider rifles are identical in principle with the converted Enfields before described; the riflings are different, but the chambers are similar. In all these, however, the hammer flies back automatically to half-cock after firing. The weight of 60 rounds packed is, for the large bores, 5 pounds 10½ ounces, for the medium 5 pounds 2 ounces, and for the small bore, 4 pounds 11 ounces.

It is curious to notice that among the competitors at these trials are found many names well known in connection with fire-arms—old houses and firms—whose guns have been beaten by those of amateur gunmakers, of whom, till this crisis came, the world and the trade knew nothing. The Birmingham Small-arms Company were represented by the rifle of Mr. Gray, a small bore 0.451 calibre, with a cast-steel barrel. In firing for accuracy, the first cartridge jammed the action, and the *ramrod* had to be used to clear the gun. For rapidity, the firing was

iscontinued at the sixth round, the base of the cartridge having torn ff, leaving the case jammed in the cylinder.

Messrs. Benson & Co. had four rifles at the trial—three on the olt system, and one on the breech-block principle, similar to the Mont torm. The result of the firing with these guns was simply a series of iishaps, not one of the four reaching mediocrity. The Westley Richards ompany had four rifles here also, not one of which completed the ractice. One only (No. 3) made a respectable show when firing for ac- uracy, but when firing for rapidity, it became unserviceable at the sixth ound.

A Prussian gun, needle principle, furnished by a Mr. Tanner of Silesia, iade very wild shooting, and when firing for rapidity the fifth cartridge ould not be forced into the chamber, and the soldier's thumb was deeply ut by the sharp edge of the breech in endeavoring to load. The Vhitworth company's rifle was withdrawn, and generally the guns of he best known English makers were not only beaten by outsiders, but y almost all the American guns at the competition. The table on page 42 rill, at a glance, enable a comparison to be made of some of the results f this primary competition; for the object of the trials above mentioned ras merely to facilitate the selection of a number of weapons for a more horough competition. From among the names in the table some ten or dozen will be selected[1]. The makers will be required to furnish six ifles each (of the pattern of the experimental weapon) and 1,000 rounds f ammunition. For this each maker or inventor will receive £300, and he competition for the two prizes of £1,000 and £600 will then be pro- eeded with.

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[1] Since writing the above, we learn that the following nine rifles have been selected: Albini nd Braedlin, Berdan, Fosbery, Henry, Joslyn, Martini, Peabody, and Remington; one of ie makers having two guns representing different systems.

Table of most prominent guns at the primary breech-loading competition in England.

Maker or Inventor.	Nationality.	Principle.	Calibre.	Fulminate.	Charge.	Bullet.	Weight of sixty rounds.	Rapidity, twelve rounds in—	Remarks.
Barton	British	Breech-block	0.577	Central fire	75 grs	480 grs	6 lbs. 11 oz	57 sec	Worked well.
Do.	do	Bolt with piston	do	do	do	do	do	1 m. 2 sec	Similar to Prussian needle gun.
Braedlin	do	Mont Storm	0.462	do	68 grs	do	6 lbs	1 m. 31 sec	Worked well.
Berdan	American	do	0.577	do	75 grs	do	6 lbs. 11 oz	57 sec	do.
Cooper	British	Bolt with piston	0.463	do	70 grs	do	6 lbs. 2 oz	1 m. 2 sec	do.
Fosbery	do	Mont Storm	0.577	do	75 grs	do	6 lbs. 11 oz	50 sec	do.
Henry	do	Breech-block	do	do	do	do	do	49 sec	do.
Hammond	American	Peculiar	0.466	Rim fire	Not known	380 grs	4 lbs. 11 oz	1 m. 1 sec	do.
Joslyn	do	Breech-block	0.500	do	76 grs	394 grs	4 lbs. 14 oz	47 sec	do.
Martini	Swiss	do	0.433	do	72 grs	334 grs	4 lbs. 9 oz	48 sec	do.
Peabody	American	do	0.500	do	60 grs	395 grs	4 lbs. 10¾ oz	53 sec	do.
Remington	do	do	do	Rim or central	67 grs	407 grs	5 lbs. 2 oz	50 s. with cent'l fire. 44 s. rim fire	do.
Sharp	do	do	do	Rim fire	do	487 grs	4 lbs. 13¼ oz	51 sec	Cartridge 1.89 inch long.
Soper	British	do	0.570	Central fire	71 grs	533 grs	6 lbs. 10¼ oz	39 sec	Accuracy, good.

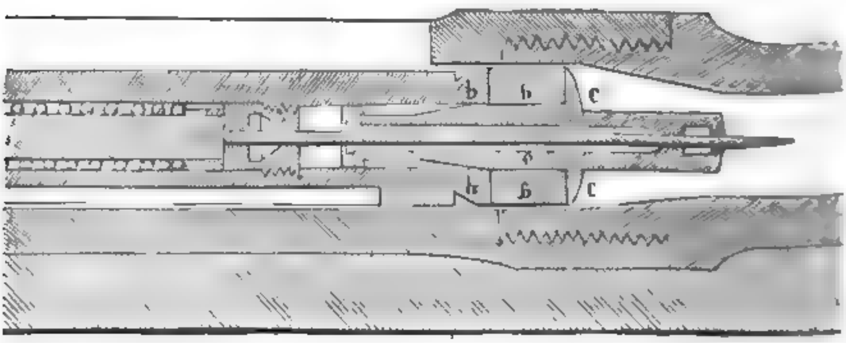
From this table it will be seen that six out of these 14 competitors are nerican,[1] whilst two others are founded on the Mont Storm principle, o an American invention. Of the 14 guns, eight are for central-fire, d six for rim-fire cartridges. The only case in which the two systems ignition are fairly compared is in the Remington rifle, which fires her cartridge, but which made the most rapid shooting with the rim-ɜ. The gun which carried away the palm in rapidity of fire was Mr. per's, but the delicacy and complication of its mechanism are strong guments against its adoption as a military arm. The lightest 60 rounds that of Mr. Martini, of Switzerland, who also has the heaviest charge powder in proportion to the weight of the bullet. The average weight the rim-fire charges and bullets are to each other as one to six, while ɜ central-fire are nearly as one to seven, hence the former will be able to ain a greater range with a lower trajectory. The average weight of ɜ central fire 60 rounds is 6 pounds 8½ ounces, while the average of the n-fire is 4 pounds 12½ ounces; consequently 80 rounds of the latter are heavier than 60 rounds of the former, a consideration, taken in con-ction with rapid firing (consequent on the introduction of breech-loaders) d forced marches, of no secondary importance, at least to the infantry ldier. The average rapidity of the firing with the central-fire cartridge, above, is 58¼ seconds, and that of the rim-fire 50⅜ seconds. It is also rthy of notice that besides those in the table, there were 68 central-fire ns at the competition, nearly all of which missed fire frequently, and her wholly failed, or at least did nothing to entitle them to further nsideration, whilst no rim-fire gun missed or failed; indeed, all the ns using rim-fire cartridges are in the table. There is, however, some-ing to be said in extenuation of such wholesale failure of the central-ɜ weapons. The makers or inventors seemed to fancy that their guns uld stand a better chance of being adopted if made to suit the Boxer service cartridge, for the manufacture of which an extensive and costly nt of machinery has been got up at Woolwich arsenal. This may be ɜ reason why most of the competing rifles were designed for central-ɜ cartridges. The same consideration may probably induce the British vernment to adopt some central-fire gun, notwithstanding that the st prize may be won by the other system. The guns, however, which n the prizes at this competition, or may be considered the simplest and st, will still have to compete with the Snider-Enfield.

THE CHASSEPOT RIFLE.

The Chassepot rifle, the weapon of the French army, is exhibited by ssrs. Caen, Lyon & Company, of Paris, (who manufacture the gun the government,) and also by several private gunmakers. It is a

While these and similar trials were progressing in England and other countries, several el and interesting weapons and methods of conversion were being perfected in the United tes; among these the Broughton and the Roberts guns—which latter has been adopted the State of New York—deserve more than a passing notice. See Appendix.

needle-gun, differing from the Prussian arm in two particulars: First, the escape of gas is not prevented, as in the Prussian needle-gun, by the perfect mechanical fit of the needle-bolt and the barrel. Second, the fulminate is not in front, but in rear of the charge, and is contained in an ordinary copper cap. The chief feature of the invention, however, consists in the contrivance adopted for preventing the escape of gas breechwards. The hermetic closing of the breech parts is obtained by the instantaneous compression, under the action of the explosion, of a vulcanized caoutchouc washer interposed between the front face of the breech-bolt and a flange, or shoulder, upon the needle-guide. The needle-guide being movable, and the front face of the bolt being fixed, the india-rubber washer is nipped between them. The washer and the flange or shoulder are of little less diameter than the breech in which they are fitted, so as to facilitate their play therein, but the diameter of the front face of the breech-bolt is, as nearly as possible, equal to the inner diameter of the breech. When the explosion takes place, the pressure transmitted by the movable needle-guide to the washer is such, that the latter is compressed sufficiently to hermetically close the rear end of the barrel and thereby prevent all gas-escape. After the charge is fired and the pressure removed, the washer, by virtue of its elasticity, returns to its natural position. The ring or washer is composed of three layers of different degrees of hardness, the two outward layers being of much harder substance than the centre one, so that, on being pressed, the intermediate layer, which is perfectly elastic, expands. A reference to our



The Chassepot rifle.

woodcut will sufficiently explain the nature of this breech-closing arrangement. The india-rubber ring *a* is compressed by the needle-guide C between the washers *c b* when the charge is ignited, and is therefore forced to fill the barrel, in which, in its normal state, it is a loose fit. This arrangement seems to answer well, and if the copper cap and base of the cartridge can be got rid of effectually after each discharge, the Chassepot (despite the perishable nature of its elastic washer, which

however, can be easily renewed) bids fair to be a more effective and trustworthy weapon than the Prussian needle-gun.[1]

The following particulars relate to the Chassepot rifle:

	French measurement.	English measurement.
Weight	4 kilos. 50 grams.	8 lb. 14 oz. 13 dr.
Calibre	11 m. metres.	.433 inch.
Range	1,000 metres.	1,094 yards.
Weight of cartridge	31 grams.	578.4 grains.
Weight of ball	24 grams.	370.4 grains.
Weight of charge	5½ grams.	84.8 grains.
Number of grooves		4

No reliable data has yet been obtained for comparing the merits of the Chassepot with other breech-loaders. It was not among the competitors either in England or at Vienna, and the French trials are generally conducted in secret, save when it is considered necessary to give *eclat* to an invention adopted by the government. In these cases the trials consist more of the nature of a display than experiments. The following account of a trial of the Chassepot rifle, which lately took place before the Emperor and Prince Oscar of Sweden, appeared in *The Times* of the 18th of May:

"A battalion of the foot chasseurs of the guard was placed at 600 yards from the mark, and the results obtained were quite extraordinary. After a period of precisely two minutes, the trumpet sounded the call to cease firing. It was then found that the battalion (500 strong) had fired 8,000 balls, of which 1,992 had struck the line of object aimed at. All the ground immediately in front of the mark was cut up by the balls in such a way as not to show a blade of grass left. The Emperor uttered an exclamation which graphically depicts the result: 'It is frightful! It is a positive massacre!' The battalion afterwards executed several times a similar exercise, but at distances increased to 1,000 yards."

Here the average number of shots per man was 16, or at the rate of eight rounds per minute, while the number of hits was nearly 25 per cent., which, at 600 yards, may be considered good shooting. There is, however, something very vague about "the line of object aimed at."

[1] Since the above was waitten, the experiments referred to in the following paragraph from *The Illustrated London News* were made in Prussia: "The Prussian gunmaker Specht has received from Paris a Chassepot gun similar to those adopted by the French army, and experiments have been made with it which, according to the Prussian journals, have furnished important results. The Chassepot is certainly superior to the Prussian needle-gun. Competitive essays have been made with the two. More than 50 officers of all arms witnessed them. The Chassepot was in the hands of M. Specht; the needle-gun in those of one of the best marksmen in the garrison. The arrangement was to fire with each weapon for a minute. The needle-gun was the first; it fired eight rounds and struck the target eight times. The Chassepot fired ten shots and was loaded the eleventh within the minute; it also reached the target eight times. The two guns were afterwards fired together during half a minute; the needle-gun discharged three shots, the Chassepot five. Six of them were found to have struck the target, but from which of the guns was not known."

Independent of the great number of Chassepots manufactured for the French government, Messrs. Caen, Lyon & Co. have lately received an order for 20,000 of these guns from the government of Japan, and it has also been selected for trial by the Italian, Spanish, and other European governments that have not as yet adopted any breech-loading system.

FRENCH BREECH-LOADERS.

M. Devisme, of Paris, exhibits a gun which seems to be a compound of the Chassepot and the Prussian needle-gun. It is a needle-gun, and the breech is closed, as in the Prussian gun, with a gas-tight metallic joint like a conical valve. The chief novelty is the manner of fixing the breech-bolt. The bolt slides in a groove in the stock, which groove is a continuation of the barrel of the gun. Midway in this groove the bolt passes over a transverse rod or shaft which projects into the bottom of the groove, and is hollowed out to admit of the breech-bolt passing over it. There is a corresponding hollow in the breech-bolt, and when it is pushed home this hollow is immediately over that of the transverse rod, which has a lever attached to its end, and when this lever is pulled half a turn the round side of the transverse or locking-rod is brought into the hollow of the breech-bolt, and the breech closed. This locking arrangement seems to be very effective, but it necessitates an extra movement—throwing the handle below the barrel, and again towards the handle of the bolt—whereas in the Prussian and Chassepot guns the breech-bolt is both handle and fastener. We are not aware that Devisme's gun has taken any prominent place in the competitions now going on, though the inventor avers that it can fire 15 times per minute. It has—in common with the Prussian needle-gun—the advantage of being speedily rendered unserviceable by simply withdrawing the breech-bolt, and the disadvantage of its working parts being too much exposed in wet weather.

Messrs. Jarre & Company, of Paris, exhibit a novel breech-loader, which can be fired, they say, 50 times a minute. It is in some respects a magazine gun, and yet it differs greatly from the American guns of that denomination in the Exhibition, and it has one advantage over them, namely, that the unfired charges are always in sight; the soldier knows not only when his gun is empty, but how many rounds remain to be fired. The charges—ten in number—are arranged in a sliding breech-block, which moves laterally through a slot in the stock by the action of cocking the gun, so as to bring one charge at a time opposite the barrel, as in a Colt's revolver. Each cartridge (rim-fire) has a small pin projecting from the flange of its base, and which receives the blow of the hammer vertically. The charges, to facilitate the loading of the breech-block, are (when manufactured) tied together in rows of ten, and are fixed upon a piece of wood by a string. The conical ends of the bullets, which project slightly beyond the piece of wood, are inserted in the breech-block, and a slight pull of the string disengages the ten rounds, and they

fall into their places in the block and are locked in by a bar hinged to the block at one end, and locking with a spring at the other; the fresh supply of 10 cartridges are then ready for firing. The whole operation of filling the breech-block occupies about 10 seconds.

Another gun in the French section worthy of notice is that of M. Tronchon. It has a breech-block on the Mont Storm system, adapted to central-fire cartridges. The breech-block turns over and is secured in position, when closed, by a vertical bolt with a projecting thumb-piece at the side. The piston works horizontally along the axis of the breech-block, the hammer falling on a hinged stud in connection with the fastening-pin, so if the hammer be let fall before the block is bolted in its place, the striker and bolt will be driven by the blow into position together. Ammunition cartridge with a thick India-rubber wad at the base; India-rubber envelope; an iron pin in the centre of wad conveys the blow of the piston to the fulminate, which is put in a cardboard sabot next the charge. This rifle was at the English competitive trials, but, like the rest of the French and German guns, it took no decided position, and left the contest chiefly between the English and American guns.

THE ELECTRIC RIFLE.

A breech-loading rifle to fire by electricity is exhibited in the French section, by M. le Baron and M. Delmas, of Caen. They say they have been experimenting for a long time on this electric system, and after many trials have at last succeeded in applying it to fancy guns, (*fusils de luxe*,) and also to military arms. The following is their explanation of the features of the gun and some of its advantages, (abridged.) All the electric apparatus and the means of applying it are placed in the interior of the stock, (see woodcut.) The cartridge cannot ignite itself by any shock, however violent, as it contains no fulminate, nor is there any necessity for caps. The cartridge is hermetically closed at the base, and so has no gas escape, and therefore the projectile has a greater range. The gun cannot go off without the action of the user, (*sans la volonte expresse*,) and as it does not require to be cocked, or need any exertion to discharge it, the aim is not disturbed. A is the galvanic pile, which is shut up in the stock by the screw-cover B; this is made to fit closely by an India-rubber washer C; D is the bobbin; E E the conducting threads, and F the magnet. When the pile is in action, the vibration of the interrupter will cause a disagreeable sound. It may also happen that this interrupter is not quick enough in movement, which would prevent the instantaneous ignition of the charge. This inconvenience can be neutralized by the magnet, which, resting on the interrupter, prevents its vibration and puts it in motion when separated. This magnet is inserted in a piece of ivory G, which isolates it from the shank or rod H, and is used to fix it there. The bell-crank J is hinged to the rod, and all is put in motion by a slight pressure of the finger upon the button

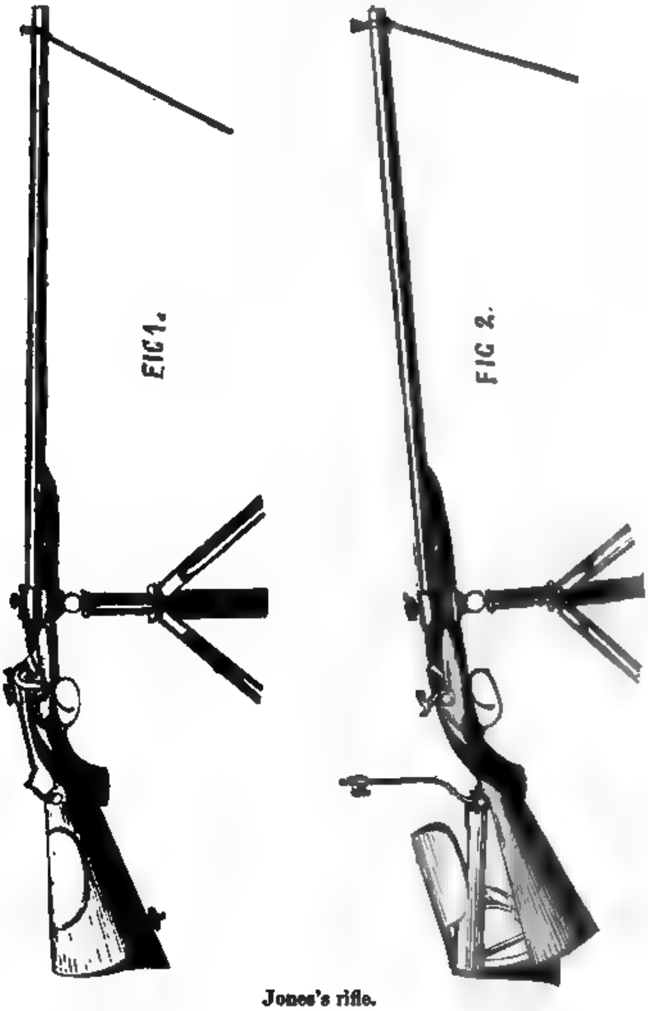
K. The rod H slides within the stopping-guide L, and separates th magnet from the interrupter, and then only the spark is produced The spring M, pressing upon the heel of the crank, replaces the butto K in its normal position as soon as the pressure of the finger i removed. To prevent accidents, the piece N slides upon the band S s as to cover the button K. This piece is fixed by an interior spring t prevent it from moving accidentally, and this spring has a branch whicl comes between the button and the heel of the crank to prevent it fron acting. O P are the two conducting wires. The latter passes througl an insulator R of ivory or hard gutta-percha, and at its extremity i placed a disk of platinum. To give the stock the necessary strength, tw bars of brass or steel, S T, are inlaid in the stock, and the two sides ar held together by screws passing through internal bosses. The cartridg has a base of thin cardboard or linen. The action of the breech is some what similar to the Hammond gun, and an ordinary trigger can be use if deemed expedient. *The London Times*, in speaking of this gun says "If M. le Baron could simplify and diminish the apparatus, it migh supersede all hammers, anvils, and caps, but at present it weakens the stocl too much." *The Times* might safely have gone a little further, and stipu lated for an unfailing certainty of action during thunder-storms and i changeable weather. The breech-loading systems that we have bee considering have already disposed of caps as a separate nuisance, an the American rim-fire cartridge disposes of the anvil, so there remain only the hammer, which is more easily carried and less liable to get ou of order than a galvanic battery with its pile, bobbins, conductors, an insulators; in short, a complicated mechanical and chemical arrangement to understand and manage which every soldier would not only requir to be a practical mechanic, but a graduate in chemistry.

Before finally taking leave of breech-loading small arms, it may b well to say that in the Austrian, Italian, Swiss, and some other section there are many guns to which we have not alluded. They are generall crude in design, rough in workmanship, and contain no principle or nov elty that would be likely to develop itself into a good breech-loadin arrangement. Regarding this class of weapon it has also been difficu to obtain accurate information the tendency of inventors who have take to a subject with which they are not familiar being to exaggerate th importance of their inventions. Hence, instead of a simple descriptio of any particular gun, a highly colored list of its advantages is furnishe Guns of this class abound in the French section also, the exhibitors which (following doubtless the example of their government) are unwi ling to give any information, beyond their own views, of the suppose advantages of their weapons. Four Chassepots and 11 other guns different epochs are among the munitions of war exhibited by the Fren government; but in no instance are the cases opened before any strang without the special permission of the minister of war, and without su *permission* the guardians are not even allowed to answer any questio

ting the articles exhibited. The Chassepot, however, is shown y, and explained by Messrs. Caen, Lyon & Co., the contractors, hiefly supply the gun to the government. In the British sec- iere are few breech-loaders exhibited. Among these, in addition se already named, Green's system, exhibited by Messrs. Reilly & ' London, is perhaps the most promising; though originally devised porting rifle, it may easily be adapted for military purposes; it has ovements, and works on the bolt principle by a very simple action.

THE JONES RIFLE.

al novelty in fire-arms is exhibited in this section by Mr. Jones, of nham, England. It is not, strictly speaking, a military arm, being



Jones's rifle.

ed to facilitate firing with accuracy and ease. At long ranges ld chiefly be useful to sharpshooters. The invention is designed

to correct the anomaly of shooting at long and short ranges with a stock of the same bend. By a simple mechanical contrivance the rifle can be adjusted from the level barrel to any elevation up to six degrees. The part of the stock bearing on the shoulder is hinged, and moves so as to preserve the same position whatever be the elevation of the gun; the marksman is thus enabled to maintain an easy position under every diversity of range. Fig. 1 shows the movable stock and sights arranged for firing point-blank, and Fig. 2 shows the stock arranged for an elevation of five degrees, at which point the part of the stock which rests on the shoulder has the same relation to the sights as in Fig. 1.

In regard to breech-loaders proper, whatever objections may be raised against them on account of their tendency to waste ammunition, it is plain that in future wars they will occupy an important place, and that the nation which neglects to adopt some good breech-loading gun for its armies will stand on a slippery basis. It is difficult at this stage of the question to designate the best weapon, or the best cartridge, nor does the action of the European governments as yet help to throw much light on the subject.

The French and English only seem to have adopted some specific system. The first, doubtless, because it is a necessity to be armed with some good weapon now, rather than because the Chassepot is really the best that has been tried. England makes no secret of the fact that the Snider was not adopted because it was the best breech-loader, but on account of its adaptability to the conversion of the Enfields already on hand. There are rumors and reports that the Swedes and Swiss have adopted the Remington, the Dutch the Snider, Portugal and Italy the Westley Richards, Russia the Berdan, and Turkey, Lawson's; but it is doubtful if any system, in this age of invention and change, will be fully and finally adopted by any of the leading military powers, at least until the cartridge question is set at rest. The needle-gun, or self-consuming, the central, and rim-fire cartridges are all contending for the supremacy, and each system has its advantages and its disadvantages; to weigh and adjust these, so as to get at the truth, will be a work extending over a long period of time. Meanwhile, the gun which combines simplicity of construction and a reasonable rapidity of firing, with a good range and a low trajectory, cannot fail to attract attention, whether the charge be ignited by a spark in the centre or by a ring of fire around its base.

CHAPTER III.

FIELD ORDNANCE.

DISPLAY AT THE EXHIBITION—ARMSTRONG AND WHITWORTH COMMITTEE—COMMITTEE ON BREECH-LOADING GUNS—TABLE OF RESULTS—ARMSTRONG VENT-PIECE—ARMSTRONG AND WHITWORTH MUZZLE-LOADERS—TWELVE-POUNDER FIELD-GUNS—BREECH-LOADING FIELD-PIECE—WHITWORTH'S TWO-POUNDER—EFFECTS OF CASE-SHOT—FRENCH GUNS—EMPEROR'S GUN—KRUPP'S GUN—KRUPP'S RIFLING—KRUPP'S WROUGHT-IRON CARRIAGE—DUTCH GUNS—GATLING BATTERY—AUSTRIAN FIELD-GUNS—GERMAN FIELD-GUNS—FERRIS GUN—CANNON DESTROYER—MACKAY GUN.

DISPLAY AT THE EXHIBITION.

There is considerably less of what is novel and interesting in matters connected with the field-guns displayed at the Exhibition, than in other branches of fire-arms. It has often been observed, that the public can only entertain one idea at a time, and at present that idea in regard to munitions of war seems to be "breech-loading small-arms." We by no means aver that there is *nothing* novel in field ordnance at the Exhibition, but that the question of arms for infantry has eclipsed for a time all other warlike considerations. The "Gatling battery" and "Ferris gun" in the American section are of themselves sufficient to prove that field ordnance has not come to a stand-still, though the latter gun ought probably to be placed among heavier ordnance. The chief question that meets us at the outset of our inquiries is the manner of loading the gun. Shall it be a muzzle-loader or a breech-loader? The late Austria-Prussian war, especially the battle of Sadowa, has settled this question so far as relates to small-arms. But there is still a great diversity of opinion on this subject in regard to field, battery, and naval ordnance. Perhaps no abstract question has ever been subjected to such a trying and practical test as this now under consideration during the celebrated Armstrong and Whitworth trials in England. These trials lasted from January, 1863, till August, 1865, and cost for ammunition alone £33,500, ($167,500.)

On entering the Exhibition by the "*Grande Porte*," the first building on the right, opening on the main avenue, is devoted to the British munitions of war exhibited by inventors and private firms, and among these figure conspicuously the rival systems of Whitworth and Armstrong. A twelve-pounder field-piece, similar to those used at the said trials, is shown by each of these exhibitors. At the trial, however, Sir William Armstrong had two twelve pounders—a breech-loader and a muzzle-loader. The former is not on exhibition. Before proceeding to speak of either of the guns exhibited, we purpose to refer to such features of the competitive trials as bear upon the manner of loading the gun. It

being understood that Sir William Armstrong was to furnish both a breech-loader and a muzzle-loader, the committee received from the War Department the following instructions:

ARMSTRONG AND WHITWORTH GUNS.

"*Instructions for the Special Armstrong and Whitworth Committee.*—The committee are appointed to examine and report upon certain facts, which require to be carefully ascertained before any satisfactory opinion can be pronounced upon the different descriptions of guns and of ammunition proposed by Sir W. Armstrong and by Mr. Whitworth.

"It is intended that the inquiry should embrace the fitness of the guns and ammunition for the various purposes to which ordnance may be applied, namely—*For land service:* 1. Field-guns. 2. Garrison-guns. 3. Siege-guns. 4. Heavy guns for coast defences. *For sea service:* 1. Broadside-guns. 2. Pivot-guns. 3. Boat-guns. 4. Guns for cupolas. *Applicable to both services:* 1. Guns for use against iron plates.

"The committee, in considering the fitness of the guns for the several purposes above named, should report upon the comparative qualities of the different guns and ammunition under the separate heads of—Range, Initial velocity and retardation, Accuracy, Penetration, Ease of working, Recoil, Rapidity of firing, Capacity for firing different kinds of projectiles, Apparent capability of standing the rough usage of actual service, so far as can be ascertained from—Endurance, Capability of bearing continued firing with the maximum charge adapted to the gun, Simplicity of construction, Facility of repair, and Comparative cost, so far as can be ascertained, before the manufacture has been systematically established.

"The committee will report upon the suitableness of these guns for muzzle-loading and breech-loading.

"As the committee may not have an opportunity of comparing guns of the same weight, they will carefully note the comparative weight of all guns examined, and also their calibre, their material, their construction, their system of manufacture, and they will state any facts on these points which experiment may enable them to ascertain.

"In considering the projectiles, fuzes, and ammunition proposed, the committee should include in their inquiry—*For field guns:* 1. Solid shot. 2. Segment (or shrapnell) shells, with concussion and time fuzes and bursters. *For garrison and siege guns, and guns of position, and for guns for sea service:* 1. Solid shot. 2. Segment (or shrapnell) shells, with concussion and time fuzes or bursters. 3. Common shells with percussion fuzes. *For use against iron plates:* 1. Solid shot. 2. Shells and fuzes.

"They should give their attention to the various purposes for which projectiles would be required to be used with each class of gun, such as against troops at long or short ranges; against earthworks, masonry, or iron defences; against wooden, iron, or iron-plated ships, either from

other vessels or from fixed batteries; for ricochet fire, penetration under water, &c. They should not overlook the applicability of the guns submitted to them to employment with special projectiles, such as shells filled with molten iron, &c. They should report on the material and shape of the various projectiles for the different purposes required. They should also satisfy themselves as to the fitness of the various projectiles and their parts to bear carriage, whether in limbers, ammunition wagons, or on board ship; their liability to deteriorate by damp, immersion in water, hot climates, &c.; their simplicity of construction; freedom from liability to injury by rough usage; and comparative cost, so far as can be ascertained, before the manufacture has been systematically established.

"In considering guns and projectiles intended for use against iron plates, they should have regard to their penetration, both when fired obliquely and at right angles to the target; to their smashing effect, as well as to their destructive power after passing through the plate. On these points the results obtained by the inquiries of the Iron Plate committee should be fully examined.

"As a great number of experiments have been made of late years with the guns and projectiles proposed both by Sir W. Armstrong and by Mr. Whitworth, the committee should examine the officers who have conducted them, as well as those who have had experience of the use of any of the guns brought under their notice with troops, either in the field, or in time of peace, or on board of ship. They need not repeat experiments of which the results have been already ascertained by competent witnesses, but will direct their special attention to elucidate such points as may appear to them to require further examination.

"To guide the committee in this inquiry, all the information in the possession of the War Office, the Horse Guards, and the Admiralty will be placed at their disposal; and they will make application to the War Office before incurring expenditure for such experiments as may be deemed necessary.

"The committee should report from time to time, so soon as the facts under any one head of their inquiry shall have been ascertained."

BREECH-LOADERS.

Colonel Miller, R. A., lately read a paper before the Royal Artillery Institution at Woolwich, on "the comparative advantages of breech-loading and muzzle-loading systems for rifled field artillery." Colonel Miller was secretary of a committee of artillery officers, which was appointed last year to report upon this question of breech and muzzle-loading field guns. The committee made the Armstrong and Whitworth experiments the basis of their inquiry. Now the primary committee—the Armstrong and Whitworth—had gone very exhaustively into the question. They examined 27 witnesses experienced in the manufacture or use of artillery, whose evidence embraced 4,132 questions and answers.

They carried out, during 21 months, a series of trials which seemed to test every phase of the question, and in regard to the relative merits of the different systems of loading, they found as follows:

"That the breech-loading gun is far inferior as regards simplicity of construction to either of the muzzle-loading guns, and cannot be compared to them in this important respect in efficiency for active service;" and again, "That both Sir W. Armstrong's and Mr. Whitworth's muzzle-loading systems, including guns and ammunition, are on the whole very far superior to Sir W. Armstrong's breech-loading system for the service of artillery in the field."

Colonel Miller classifies the practical test to which the guns and ammunition were submitted as follows:

A. *Shooting qualities*—as to (1) range; (2) initial velocity and retardation; (3) accuracy.

B. *Practical effect in the field* against—(4) earthen field-works; (5) walls; (6) stockades; (7) field artillery; (8) targets representing bodies of troops.

C. *Service of the guns*—(9) ease of working; (10) rates of firing; (11) extent of recoil; (12) boat service.

D. *Hard usage and rough work*—(13) endurance; (14) strength; (15) power of withstanding effect of a shell bursting inside the bore, and (16) of a shell striking the outside; (17) capability of being brought into use after being upset.

E. *Durability of the ammunition*—(18) under travelling; and (19) under exposure to wet.

TABLE OF RESULTS.

The results of the contest, as between the Armstrong muzzle-loader and the Armstrong breech-loader, and exclusive of the Whitworth, are expressed in the following table, in which the gun that answered best is shown by the figure 1, and equality is donated by the sign = :

Trial.			Breech loaders.	Muzzle loaders.	Remarks.
(1) Range		shot		1	Mean errors .... 19.3 and [illegible]
		segment shell	1		Mean errors .... 5.92 and [illegible]
(2)	Initial velocity	shot		1	Mean velocities .... 1,246 and [illegible]
		segment		1	Mean velocities .... 1,248 and [illegible]
		shell		1	Mean velocities .... 1,238 and [illegible]
	Retardation	shot	1		Retardations .... 190 and [illegible]
		segment	1		Retardations .... 189 and [illegible]
		shell	1		Retardations .... 184 and [illegible]
(3) Accuracy		shot		1	
		segment shell	1	1	
		shell	=		Under ordinary circumstances.
(4–8) Effect in the field			=	=	By special arrangements.
(9–10) Ease of working and rate of firing			1	1	Without lubrication.
(13–17) Hard usage, &c			=	=	
(18–19) Durability of ammunition				1	

Thus the balance of advantages lay on the side of the muzzle-loader; ›me other advantages that could not be tested at these trials have been aimed for the breech-loader, the chief of which is, "that by carrying off ıe breech-piece the gun is rendered useless to an enemy." But advantages ıat are suggestive of defeat seldom receive much attention. On the :her hand, Colonel Miller enumerates no less than ten disadvantages inhe- ›nt in Sir William Armstrong's breech-loader as compared with his muz- e-loading gun, viz., the liability of the breech-action to become unfit ›r use by the fracture of the vent-piece, by jamming from rust, grit, or ›cidental injury, or by the gas-check becoming imperfect from any of ıese causes; the liability, in the hurry of action, to accidents due to ıe non-screwing up of the breech; the number of separate parts and ıe delicate adjustment required, entailing the occasional employment ? skilled artificers; the projection and consequent liability to injury of ›me of the parts; the necessity for the employment of detonating :rangements to ignite the time-fuses; the difficulty of instructing ınners thoroughly in the mode of action of those fuses; the liability ? the lead coating to strip, if not very carefully secured in the first ıstance; the liability of the same coating to injury, to an extent which ıay possibly interfere with loading; the absolute necessity for the nployment of lubricators.

The following, from the report of the Armstrong and Whitworth com- ittee, will still further explain and illustrate some of these disadvan- ıges:

"Having thus described the construction of the several guns, the com- ittee have to report that, considering the number of spare articles which :ust be carried with each breech-loading gun to insure its efficiency, nd the number, weight, and cost of special tools and implements, and ıe complication in the store department consequent on their issue nd maintenance with field-batteries under all conditions of service; and ›nsidering also the necessity there is that men skilled in the use of ıese implements should always be present with each battery to use them nd keep the guns in efficient repair, they are of opinion that this gun ı far inferior, as regards simplicity of construction, to either of the ıuzzle-loading guns, and cannot be compared to them in this important espect in efficiency for active service."

ARMSTRONG VENT-PIECE.

The committee further add:

"As regards the breech-loading arrangements, the committee have ›een informed that the copper rings of the vent-pieces and bouches of he guns require refacing and renewal after a certain number of rounds, ependent on the care and attention with which the action of the powder ı observed. For this purpose complicated and costly tools, which are ifferent for every description of gun, and require a certain amount of kill in manipulation, have to be issued and always carried on service

with the guns; spare vent-pieces and copper rings have also to be carried.

"The committee have received evidence of frequent accidents having occurred with guns of all sizes from vent-pieces having been blown out in some cases, and broken in others, both in service and in practice on land as well as at sea, and as a consequence the whole of the vent-pieces in the service have been recently exchanged, a new construction of vent-piece having been approved. This vent-piece, which had not yet been generally introduced into the service, is intended to prevent a recurrence of these accidents.

"The committee desire to refer to the evidence relative to those accidents which have occurred in active service in presence of an enemy.

"Major Milward, royal artillery, reports a vent-piece having been blown out of a field-gun during the China war in 1860, through the carelessness of the man who was trusted to screw it up; by this accident the traversing apparatus on the gun-carriage was rendered unserviceable, but it 'did not in any way affect the use of the gun.'

"Colonel Barry, royal artillery, also reports that a vent-piece was blown out in China.

"Captain Seymour, C. B., royal navy, reports a vent-piece having been blown out of a 12-pounder field-piece in an expedition against some of the natives of the Fiji islands in 1861, by which the English consul was badly burnt, the officer in charge of the boat and six men were wounded, one of them seriously.

"Two similar accidents were reported to have occurred with the guns of the royal artillery in New Zealand.

"It appears also from the reports of her Majesty's ships engaged at Kagosima, Japan, on the 15th and 16th August, 1863, that with the eight 110-pounder guns which were engaged, and fired altogether 168 rounds, one vent-piece was broken, and complaints were made of the vent-piece jamming, and of great difficulty being experienced in firing one gun, in consequence of the rain wetting the vent-piece and running into the chamber. On the same occasion 187 rounds in all were fired from the thirteen 40-pounders engaged, in the course of which one iron and four steel vent-pieces were cracked, one steel vent-piece was broken, and two vent-pieces were blown out.

"These reports, which are the recorded evidence of a very limited use of the breech-loading Armstrong gun with old pattern vent-pieces on active service, may be considered as indicative only of what might be expected in more serious affairs, such as a general action or decisive battle, in which a numerous artillery would be employed; combined with other evidence they tend to show that the vent-piece is an element of insecurity which has been found objectionable even at practice, and may therefore be expected to be much more so in the hurry and excitement of action."

It must, however, be borne in mind that the above objections apply *specially* to the Armstrong breech-loader, and not to breech-loaders gen-

ally, though some of the faults of this gun will doubtless apply to other eech-loading systems, as almost all of them require some finishing ghtening touch likely to be forgotten in the heat of action. Notwithanding the conclusive nature of these trials and reports against the rmstrong breech-loader, this gun is still the field-gun of the British rmy. The breech-loading committee, of which Colonel Miller was secetary, consisted of a lieutenant general, five major generals, a brigadier eneral, and six colonels of artillery. These officers represented the present tate of field ordnance, referring to the Armstrong breech-loader as "anyhing but satisfactory, and unanimously recommended that the system hould be changed to muzzle-loaders the first opportunity." Colonel Iiller's paper, from which these particulars have been drawn, concludes:

"If we had to take immediate part in a European war, we should bring nto the field a delicate gun requiring constant care and a great variety f stores for its sole use; we should further be liable to the risk of the un failing us at critical moments; but we should not have the satisfacion of getting any advantage in range, accuracy, or rate of fire which 'ould not equally be presented by a muzzle-loading system."

The breech-loader being thus disposed of, the contest in these trials was eally between the two muzzle-loading guns, the particulars of which are one into at great length in the "Report of the Armstrong and Whitorth Committee." A few facts respecting the several points tested may e interesting. First, however, let us ascertain what the rival guns were. he report says:

"As to construction, Sir W. Armstrong in his evidence stated that 'the hole of his guns are upon what he calls the coil system, which consists n forming tubes by rolling up iron bars in spiral coils, and then welding hem longitudinally; and when a continuous tube is necessary, joining hem up in the end direction. Repeated layers of these tubes are shrunk n in succession, at high temperatures, until the necessary thickness of netal is made up. He stated that the first gun he constructed was made rith a steel barrel, the other parts all being coiled, and that he still coninued to prefer that plan, assuming it to be practicable to get a material hat can be depended upon, but that in all attempts he had made he had net with such disappointment in the use of steel, and so much uncerainty, that he had been obliged to abandon it, and confine himself to rought iron; he added, however, that so much progress was being made n the manufacture of steel, and that he himself had lately been led to uch improved methods of treating it, that he fully expected the time was ot very distant when the original idea of using steel for the barrel would e revived, and coil guns made with an internal tube of steel. His reaons for desiring to use steel instead of coiled tubes for the barrels were, hat steel is a more close, a more compact, and a more perfect material, hat it is harder and of greater durability, and that by its use defective elds would be avoided. The difficulties in making the inner tubes perect and sound when coiled had been very great; these would be avoided

if the tubes were made of steel, the employment of which he considered more important in large than in small guns.'"

Mr. Whitworth in his proposals disclaimed the intention of proposing any particular gun for the acceptance of the government; but submitted for selection, in the experiments to be made by the committee, a list of rifled guns which were being manufactured by his firm. Mr. Whitworth's system of rifling may be described in general terms as a hexagonal bore with a rapid twist, although, strictly speaking, the bore is not hexagonal, but has twenty-four surfaces. The gun is in the first instance bored out cylindrically; a part of this original bore is left in the centre of each side of the hexagon, making six surfaces. Then there are the coming-out sides of the hexagon, which give six more surfaces, and the going-in sides also six surfaces, and lastly the rounding off of the angles, which give six more, making twenty-four surfaces in all.

MUZZLE LOADERS.

The following table gives the particulars of the two 12-pounder muzzle loading guns:

	Armstrong.	Whitworth.
Weight of gun ... cwts..	8.93	[illegible]
Calibre ... inches..	3.0	[illegible] / [illegible]
Length of bore ... inches..	67.74	74.0
Length of bore ... calibres..	22.58	[illegible] / 27.1
Length of gun ... calibres..	23.91	[illegible] / [illegible]
Length of gun ... inches..	71.75	[illegible]
Rifling, one turn in ... calibres..	35.0	[illegible] / [illegible]
Rifling, one turn in ... inches..	105.0	55.0
Charge ... lbs..	1.75	1.75
Shot, weight ... lbs..	11.56	11.9
Shot, length ... calibres..	2.54	[illegible] / [illegible]
Shot, length ... inches..	7.62	[illegible]
Segment or shrapnell shell:		
Weight ... lbs..	11.5	[illegible]
Length ... calibres..	2.42	[illegible] / [illegible]
Length ... inches..	7.26	[illegible]
Bursting charge ...	1 oz.	6 or 12 drs.
Common shell:		
Weight ... lbs..	11.19	[illegible]
Length ... calibres..	3.0	[illegible] / [illegible]
Length ... inches..	9.0	[illegible]
Bursting charge ... ounces..	9.5	[illegible]
Windage of shot ... inches..	0.05	[illegible]
Windage of shell ... inches..	0.05	[illegible]

NOTE.—The two numbers given under the head of calibre in the Whitworth gun have reference to the diometers of the circumscribing and inscribing circles.

The Whitworth gun is 20 per cent. heavier than the Armstrong, and the twist of the rifling is nearly twice as rapid. The charge of both guns at the competition was the same. In regard to range the two guns

were equal when level, and at one degree elevation; but from 3 to 33 degrees, the Whitworth was from 2 to 29 per cent. superior. After firing 2,800 rounds each, the Whitworth fell off, at five degrees elevation, from 2,330 yards to 2,211 yards, and the Armstrong from 2,230 to 1,925 yards, the former being 5 per cent., and the latter 14 per cent., lost in range, which the committee considered was the result of scoring, and the consequent escape of gas by the enlargement of the bore. In firing segment or shrapnell shell point-blank, the Armstrong was five and a half per cent. superior to the Whitworth, and the latter, at 5 to 10 degrees elevation, was two and a half per cent. superior to the former. In regard to "accuracy," the committee find that "the advantage of the Whitworth gun in respect of accuracy with solid shot, as compared with the breech-loading Armstrong gun, is very marked throughout. The accuracy of the Whitworth gun with solid shot is greater than that of the muzzle-loading Armstrong gun in most cases; this is so in a very marked degree at ranges beyond 3,000 yards."

In respect to "ease of working," the two guns were about equal. They were mounted on compressor-carriages in the bows of pinnaces, and 10 rounds were fired from each, the boats having slight, but rapid, rolling, and pitching and yawing motions. The average time of each round was 90 seconds. The report goes on to say:

"The competitive guns were afterwards thrown overboard from the boats, dragged ashore through the water, sand, and shingle, mounted, limbered up, and dragged a few yards, and then brought into action and a round fired from each.

"The following are the periods recorded against each gun for the whole operation, after deducting what was due to the mounting of the carriages and limbers:

	Min.	Sec.
Breech-loading Armstrong	3	30
Whitworth	5	54
Muzzle-loading Armstrong	5	23

"The difference in time is fairly due to the difference in the weight and handiness of the guns.

"The committee had found that the Armstrong muzzle-loading gun could be fired continuously without, or with only partial, lubrication; and as they considered that contingencies might very possibly occur on active service which would prevent the employment of lubrication, the supply and transport of which must always cause an additional complication, and that therefore that gun would have a decided advantage for service in the field which should be capable of being fired with ease continuously without lubrication, it was determined to try the experiment of firing a number of rounds with only powder and shot. The Whitworth gun fired 86 rounds in 34½ minutes. The muzzle-loading Armstrong gun fired the same number of rounds in 28 minutes; both made excellent practice; but the committee did not complete the prac-

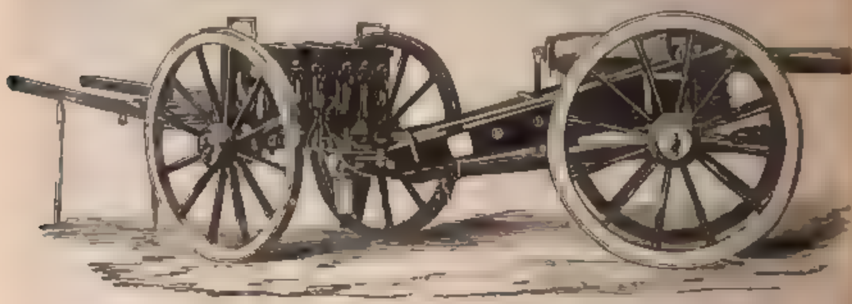
tice with the breech loading Armstrong gun, as it became evident, from the stripping of the lead from the projectile, that this gun could not be used continuously without lubricators or water. The breech loading apparatus also jammed, owing probably to the air space left by the abstraction of the lubricator."

As to "endurance," the committee say:

"It would appear therefore that though Mr. Whitworth's gun possessed greater endurance, it possessed the disadvantage, as compared with Sir William Armstrong's guns, of not giving indications, such as could have been observed on service, of the approaching destruction of the gun. The committee, however, desire to observe that these experiments exhibit a degree of strength, in all the guns, which far surpasses the possible requirements of the service."

Referring to "simplicity of construction," the report says:

"With respect to the two muzzle loading guns, they have to report that there is no very material difference as regards simplicity of construction with guns not exceeding in calibre the 12 pounders; the Whitworth gun, however, is manufactured of one material, (except the trunnion ring,) and has a like section of bore throughout; whereas the Armstrong muzzle loader is made of two materials, has a special powder-chamber, and, besides the shunt arrangement, the grooves have inclines towards the muzzle, which make the section of the bore vary."



Whitworth 12-pounder.

Regarding the cost of these 12-pounder field-pieces—about £220 ($1,100) each—the committee say:

"Both Sir William Armstrong and Mr. Whitworth object to these prices being taken as fair criteria from which to judge of what the cost of their respective guns would be if the manufacture were fully established to meet a large demand; in this opinion the committee quite concur.

"From the description given under the head of 'Simplicity of construction,' it will be evident that the two muzzle-loading guns are much about on a par with each other in respect of the processes they have to undergo in their manufacture; if anything, there is rather less work in the Whitworth, which probably is compensated by its being a hundred weight heavier, and having more steel in it, so that these two guns, if made in the same factory, and under like conditions, would be supplied at costs which, for all practical purposes, may be considered equal."

To describe the projectiles used at these trials and go, even partially, into the details of the firing would absorb the time and space necessary to do justice to other and equally-deserving guns.

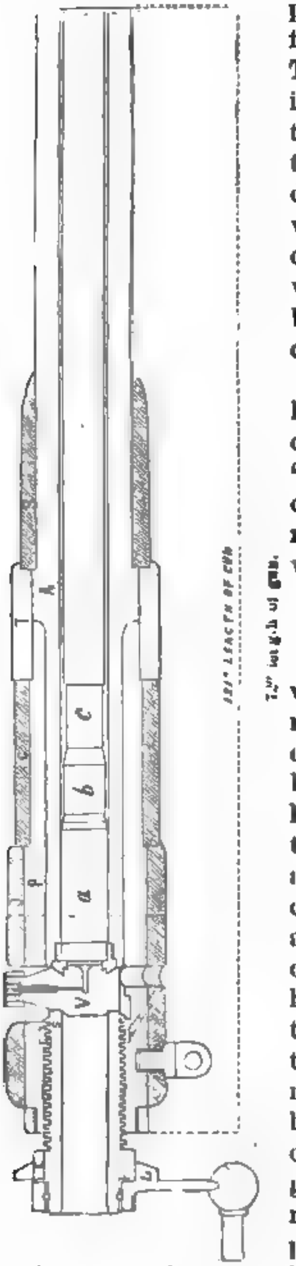
Armstrong 12-pounder.

A 12-pounder field-piece similar to those tested at these trials is exhibited by each of the inventors. These guns are represented, mounted, in the previous woodcuts. The Armstrong gun *exhibited* is, however, mounted on an *iron* carriage, with iron wheels, the spokes of which can be removed at pleasure. The elevation of this gun is regulated by the wheel and rack A, *b*, which system is now generally adopted in the British naval gun-carriage.

BREECH-LOADING FIELD-PIECE.

A breech-loading Armstrong field-piece of the same calibre is exhibited by the British government alongside of the Woolwich guns. The screw breech-loading arrangements will be readily understood by a glance at the woodcut. The breech-screw S, which is tightened or released

by the lever L, and tappet rings E, secures the vent-piece V, and thus closes the bore. The vent-piece is lifted out previous to loading, the projectile, lubricator, and charge being inserted from the rear through the hollow breech-screw. The portion of the chamber *a* next to vent-piece is not rifled, in order to admit the shot freely; the rifling gradually increases in depth through the space *b*, till, at *c*, it attains its maximum depth. The vent-piece is faced with copper, which fits against a copper ring in the bottom of the bore. The gun itself is composed of the wrought iron coil-tube A, supported by the breech-piece P, the trunnion-piece T, and the coils D C B.



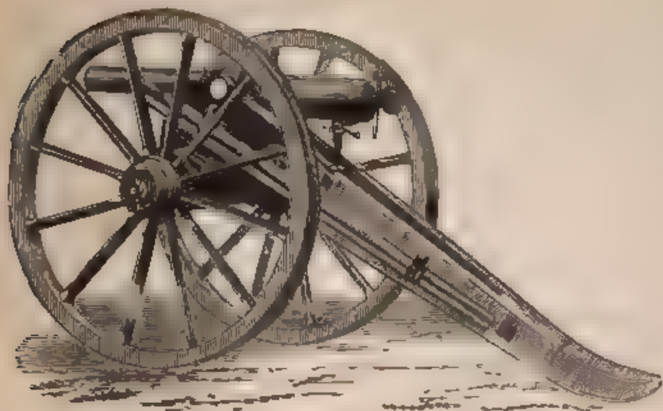
Armstrong field piece.

In the same department the government exhibit several breech-loading field-guns of larger calibre, all on the Armstrong "vent-piece" or "wedge" systems, but containing nothing special or new in the arrangements, though it may be necessary to again refer to them in connection with heavy field ordnance.

WHITWORTH 2-POUNDERS.

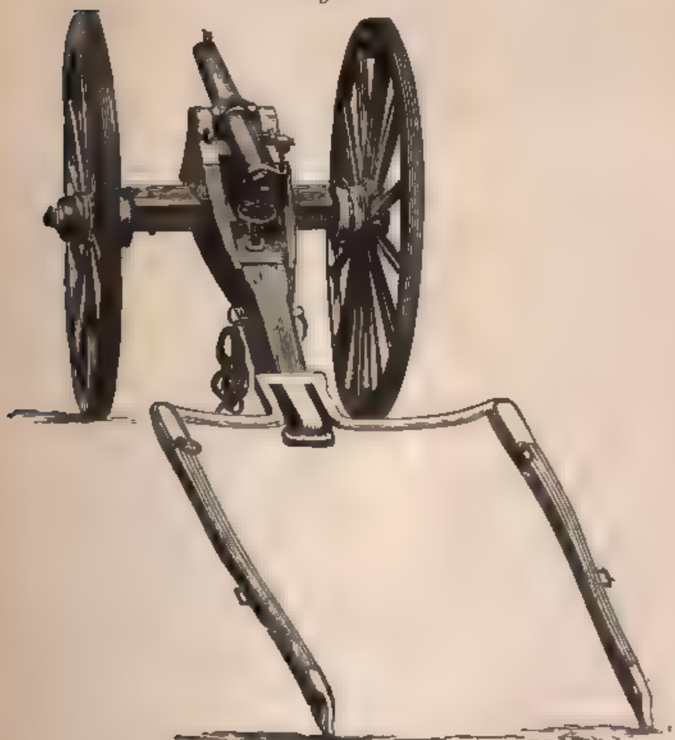
Besides the 12-pounder referred to, Mr. Whitworth exhibits a 2-pounder howitzer, designed to meet the want of a light field-piece adapted for easy and rapid transit across mountainous or broken country, or for accompanying the evolutions of detached bodies of troops. It can throw a shell of two pounds' weight, containing a bursting charge of one and a quarter ounces of powder, to a distance of 2,000 yards, with an elevation of six degrees. It may be mounted on a small carriage as in Fig. 1, which can be limbered in the usual way, or on a special mountain carriage, as in Fig. 2, which is so arranged that it can be taken to pieces and packed on mules, together with the gun and ammunition-boxes. The diagram on page 64 shows the effect of 10 rounds of common case-shot fired from this gun at a target 28 by 9 feet, and at 200 yards' range. Weight of gun, 144 pounds; shot, two pounds nine ounces; charge, four ounces and a half; number of bullets in case, 27; angle of elevation, one degree. The Armstrong and Whitworth committee reported that "the superiority of Mr. Whitworth's case-shot was very

Fig. 1.



Whitworth 2-pounder, (ordinary carriage.)

Fig. 2.



Whitworth 2-pounder, (mountain carriage)

marked throughout this practice, and the committee are of opini it is an invention of great value to her Majesty's service."

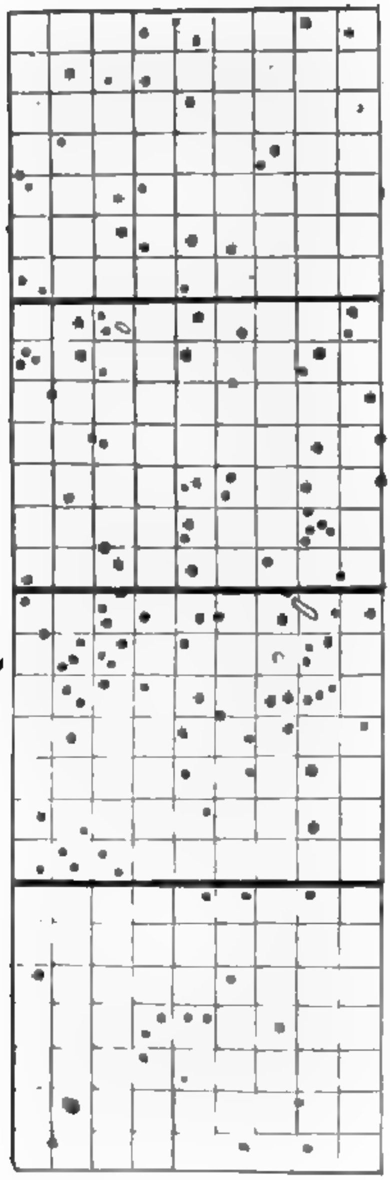


Diagram of effects of 2-pounder case-shot.

FRENCH GUNS.

The French government sho in the way of "field ordnan least little that is new or even the standard attained by less tary powers, and the little tl show is guarded from close inq with jealous care. It was a occurrence, in the earlier mor the Exhibition, to see Colonel ' husband, assisted by one of his gent non-commissioned officers round the British section expl to French, American, and oth cers, everything connected wit display of munitions of war, w the same moment British and officers were permitted to w unassisted through the collec French war materials, and wer when they asked for an expla of any matter, that it could r given without the special pern of the minister of war. Sket if not absolutely free in the l section, was not prevented, if c on without annoying the visitor mission was occasionally given tograph, and even lithograpl working drawings were som given to assist inquirers. I sketching was allowed in the l section, though as time wore on was an improvement in reg opportunities for inspection and nation, doubtless brought about example of other countries and strictures of foreign journals. animadverting somewhat severely on the display made by the l minister of war. *The Engineer* says:

"In all other departments of French industry we see progressi expansion; under the beneficent rule of the present Emperor, ent has been kindled, ingenuity stimulated, industry extended, and

increased. But in this one department there is not only stagnation, but retrogression. No doubt the inference would be an erroneous one which implied that a corresponding declension of military skill had taken place in the nation itself, and the intellect of France, if directed anew into these channels, would no doubt achieve successes which would leave all former ones behind. But in a display, such as this great Exhibition is intended to be, it would have been better either that France, in the department of military implements and apparatus, had remained unrepresented, or that she should have achieved something worthy of her ancient renown." Another article in the same number, written evidently by a different hand and without concert, says: "The exhibition of French guns is not nearly so good as that sent by the British War Department, and there is no one amongst them all of any great size, or that could compare with our 12-inch gun. With one exception, they are all constructed of gun-metal; they are all muzzle-loaders, and the rifled guns are uniformly made with six grooves. Amongst them all there was nothing to attract attention, with the exception of a small gun-metal mortar, capable of being carried by two soldiers. Inside the building is a gun-metal field-piece, with carriage and ammunition-wagon, fitted complete for service, with model horses attached, and another small field-piece, detached from its carriage, and mounted for transport on two models of horses, the one carrying the gun and the other the carriage."

There are rumors rife of an extraordinary field-gun having been invented by no less a personage than the Emperor himself, that several guns have been manufactured, companies told off to work them, and that drill practice of these extraordinary weapons is being kept up with vigor. But no indications of the nature of these guns has yet leaked out, and all connected with them are said to be sworn to secrecy. The Emperor's gun is probably a very light field-piece—a two-pounder, or even a smaller gun, intended for such service as the light cannon exhibited by Mr. Whitworth is designed for.[1] A trial has lately been arranged to take place at

[1] The Paris correspondent of *The London Standard* quotes a French letter, which says: "The Emperor Napoleon has great confidence in the small portab'e cannon; a telescope is fixed to it, which renders it easy to sight at 1,500 metres. If the improvements in the artillery as to long ranges have their advantages, on the other hand, in the opinion of some officers they have the disadvantage of making us lose all superiority with the bayonet. It is evident that in our day war must be carried on under conditions very different from the past. What, above all, is necessary, are good generals and a good staff. Do we possess them? We shall probably very soon see."

"There is," says the correspondent, "some truth in the above letter, together with a good many absurdities. For some months past columns of nonsense have been printed respecting the 'small cannon' alleged to have been manufactured at Meudon, and which have been represented as likely to revolutionise the art of war. I have reason to believe that the facts are these: The Emperor, who believes that artillery is the weapon of the future, conceived the idea last spring of supplying every battalion of infantry with mountain howitzers, which could be carried wherever infantry went, and a large number of them were manufactured; but all military men having condemned the idea; it has been abandoned. A new notion then

Versailles with Mr. Whitworth's two-pounder. The trial will be for range, accuracy, and endurance, when some light French piece is to compete with the English weapon. It is only necessary to add, that the French field-guns, and, indeed, most of their siege and battery guns, are of gun-metal. The bore is larger in proportion to the weight of the piece than the Whitworth, the Armstrong, or Krupp's steel guns. One of the most interesting pieces is the small mounted gun-metal mortar already referred to.

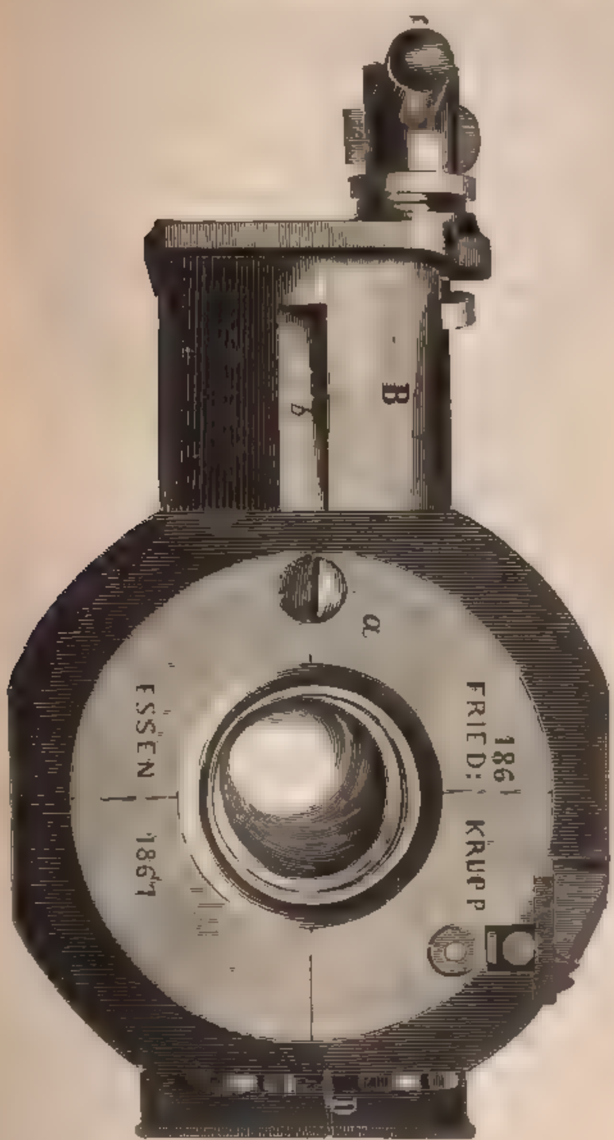
In an economical point of view the French gain an important advantage by adhering to gun-metal for the material of their field-guns. Though these may be inferior in range to good iron or steel guns, or even be shorter-lived, they can be replaced at much less cost. The material can be used again and again, and the cannon renewed as often as may be necessary, for a small percentage over the cost of the labor.

KRUPP'S GUNS.

With some points of resemblance, there is, nevertheless, a sufficiently broad line of demarcation distinguishing the chief exhibitors of field-guns in the Exhibition to entitle their productions to be considered as separate systems. If the Whitworth and Armstrong resemble each other in the mode of construction, there is a marked difference in the rifling; both differ from the French brass cannon, and all these differ from the steel guns of M. Krupp. These Essen guns are homogeneous, made of one material, and excepting the wedges and screws of the breech-loaders, of one piece of metal. With the exception of one small mountain gun, all Krupp's cannons are breech-loaders; and while the English gunmakers have come to the conclusion that breech-loading cannot be advantageously applied to heavy ordnance, or even to light field-pieces, Krupp has arrived at quite the opposite conclusion. Since the manufacture of cast-steel guns commenced at Essen, the establishment manufactured and delivered 3,500 pieces before the opening of the Exhibition, and they have (May, 1867) orders from European and other governments for 2,200 more. About nineteen-twentieths of these 5,700 cast-steel guns are rifled breech-loaders, ranging in calibre from 4-pounders to 300-pounders, with a few 600 and 1,000-pounders, their total value being about $8,500,000. These guns are rifled on the polygroove system, and use lead-coated projectiles. The illustrated breech arrangement shows that they receive the shot and charge through the extreme end of the breech, which is the case with all Krupp's guns, except the 1,000-pounder. The breech-block B is not drawn fully out in loading, but only so far as to allow the shot and charge to pass through a hole in the end of the said block. The

arose, suggested by the American revolver cannon to be seen at the Exhibition. The Emperor was greatly struck by it, and a good many of them have been made. In the opinion of French military men these weapons are very good against Indians in the far West or for operations in Cochin-China, where they may be useful on board ships' boats and steam canoes; but they are not fitted to stand the rough usage of a campaign."

ance which this block can travel is regulated by the set-screw *a*, the nt of which, when screwed up, enters the groove *b*. The engraving

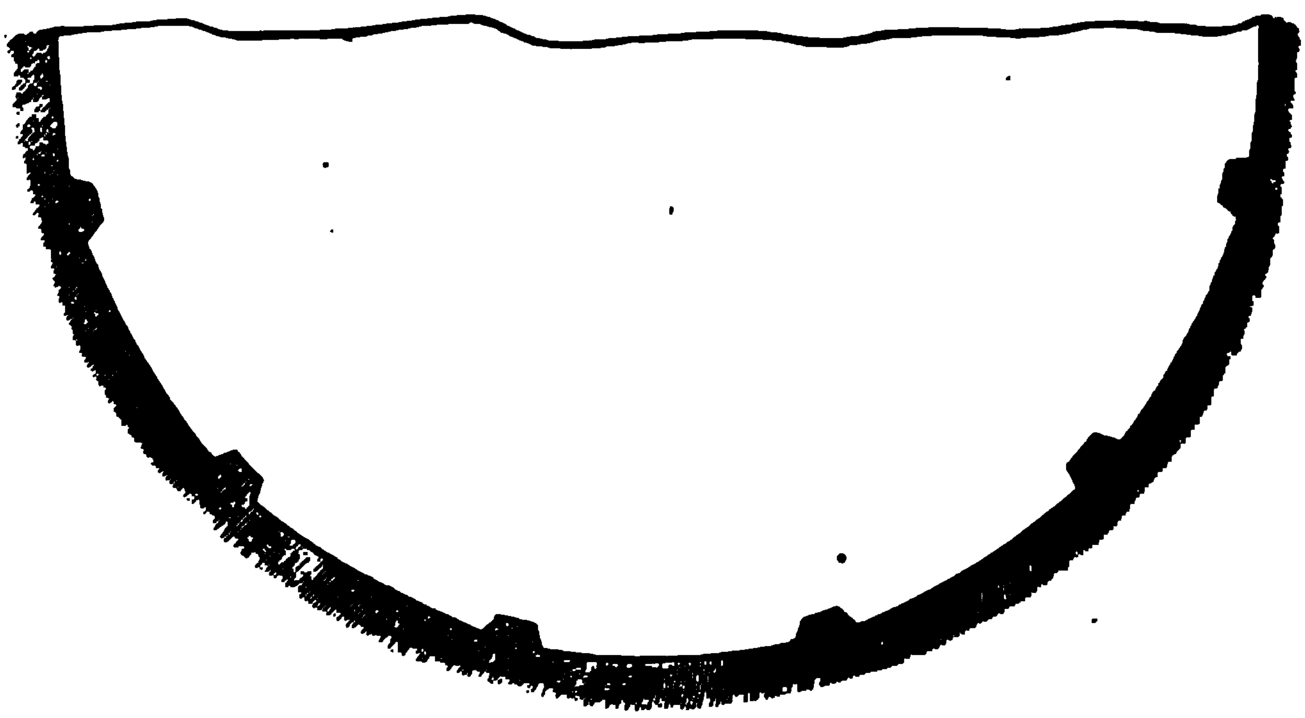


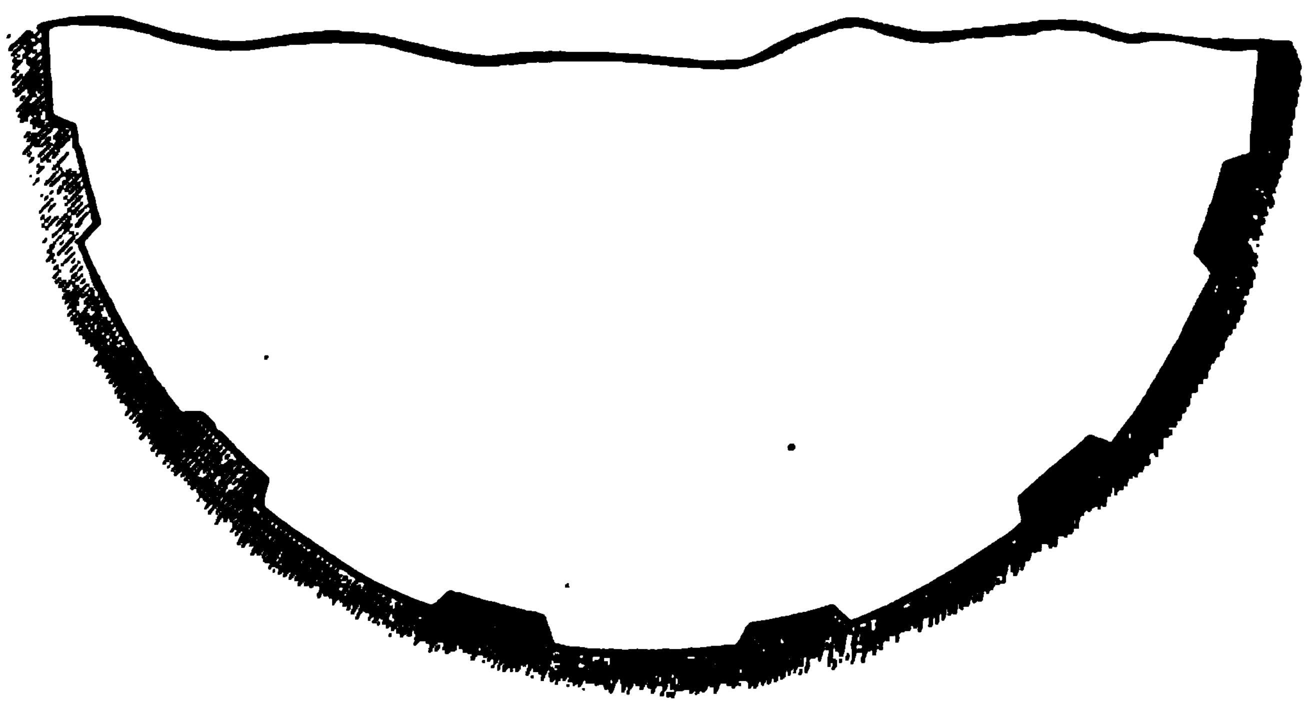
Krupp's breech-block.

s the end of the breech open, ready to receive the shot and charge. n the block is pushed in, a slight movement of the cross-lever handle ghtens it by drawing home the wedge D; the gun is then ready for g. A reverse turn of the same handle slackens the block after firing, the mechanism is so nicely arranged that none of the strain comes n this handle or the screw attached to it. The breech-block or wedge

opening in Krupp's guns was formerly square at the breech-end with the corners slightly rounded off; but this form, under heavy strains, led to distortion of the bearing parts, causing difficulty in working and ultimately resulting in the premature destruction of the gun. The opening now adopted is round at the breech-end as shown in the woodcut.

Breech.





Muzzle.

The rifling of Krupp's guns is polygrooved, and requires a lead-coated shot. The rifling is not so fine as in the Armstrong breech-loaders, nor does the coating bear throughout the whole length of the shot, as in the Armstrong, but only on four points or rings, which project about the depth of the grooves beyond the general surface. The *initial* strain of forcing this lead-coated shot into the grooves of the rifling is greatly relieved in Krupp's system by the *lands* being very narrow at the breech and widened towards the muzzle, as shown in the foregoing diagram.

A four-pounder rifled breech-loading field-piece of crucible steel is exhibited mounted on a wrought-iron carriage of Krupp's make. The gun, represented in our illustration, is the property of the Prussian war department. The gun, including the breech arrangement, weighs [illegible] pounds; the diameter of the bore is three inches. It is seventy-four inches *in total* length, and is rifled with twelve grooves. The weight of the shell

ed is eight pounds and a half, and the charge of powder is one
d. The system of breech-apparatus is "Krupp's patent semi cylin-

Krupp's held-gun.

drical wedge," or block, already referred to, fitted with a Broadwell ring. This gun, with several others of a similar make, all Krupp's, have been subjected by the Prussian minister of war to severe tests. They have been fired several hundreds of times each, with gradually increasing charges up to three and three-quarter pounds of powder, and 122 pounds' weight of shot. In no instance was the gun or breech apparatus injured, and the field-gun exhibited came from the proof in its present condition. So far, M. Krupp's light cast-steel guns have given full satisfaction, but whether the same material be as suitable for siege, naval, and battery guns of large calibre, will be inquired into when these guns come under consideration. One grand feature in favor of Krupp's guns is their homogeneity. Both these and Whitworth's (which contains a greater proportion of steel than Armstrong's) have shown a capacity for greater endurance than the general run of wrought-iron. Still the Krupp and Whitworth guns, though possessing greater endurance, have, as already observed, the disadvantage, as compared with the Armstrong, of giving no warning (such as might be observed on service) of the approaching destruction of the gun. In this respect the unreliable nature of steel tells more severely against Krupp's guns than those of his English rivals. But in an establishment like that at Essen—which produces 60,000 tons of manufactured steel annually, much of it for the most important duties of the mechanical world—it is highly probable that the manufacture of cast-steel for guns will ere long reach a satisfactory uniformity of texture—a uniformity that will enable steel guns to equal, or rather surpass, wrought-iron or brass cannon in reliability, as far as they now surpass them in sheer strength and endurance.

DUTCH GUNS.

Some old brass and cast-iron smooth-bore guns, which have been filled with molten gun-metal bored out and rifled, are shown by the government of the Netherlands. The cast-iron gun, formerly a six-inch smooth-bore, enlarged to six inches and a half, has now a calibre of five inches, which leaves a brass lining of three-quarters of an inch thick. This gun is rifled with six grooves; whether from the shrinkage in cooling, or the want of affinity between the two metals, the brass tube does not fit very snugly. There are traces of wedging and caulking about the muzzle that look suspicious. It is not stated that the gun has been proved, or even fired, and its appearance, taken altogether, holds out little hope that old iron smooth-bore cannon can be rifled and made to stand the strain of heavy charges and heavy shot by lining them with a foreign metal in this manner. The case, however, is different with the gun made of gun metal. After experimenting for several years, a perfect adhesion between the metals was finally obtained. One of the guns exhibited was filled up solid with a similar metal, bored out and rifled. The weight of the piece before filling was 763 pounds, and after it was rifled, 837 pounds. The gun was fired 2,000 times without receiving the slightest injury. It was then cut in two longitudinally and sent to the Paris Exhibition.

Though the union of the two metals can be distinctly traced, it is also evident that the adhesion is perfect. Still it is doubtful if ever this method of lining guns will be of much service. It seems as if it would cost little if anything more to recast the entire gun anew. When it is considered that this operation of filling, after boring and rifling, adds only seventy-four pounds to the weight of the gun, and that even with the greatest care faults are more likely to arise than in casting the gun anew, the latter seems to be the most sensible and the safest method.

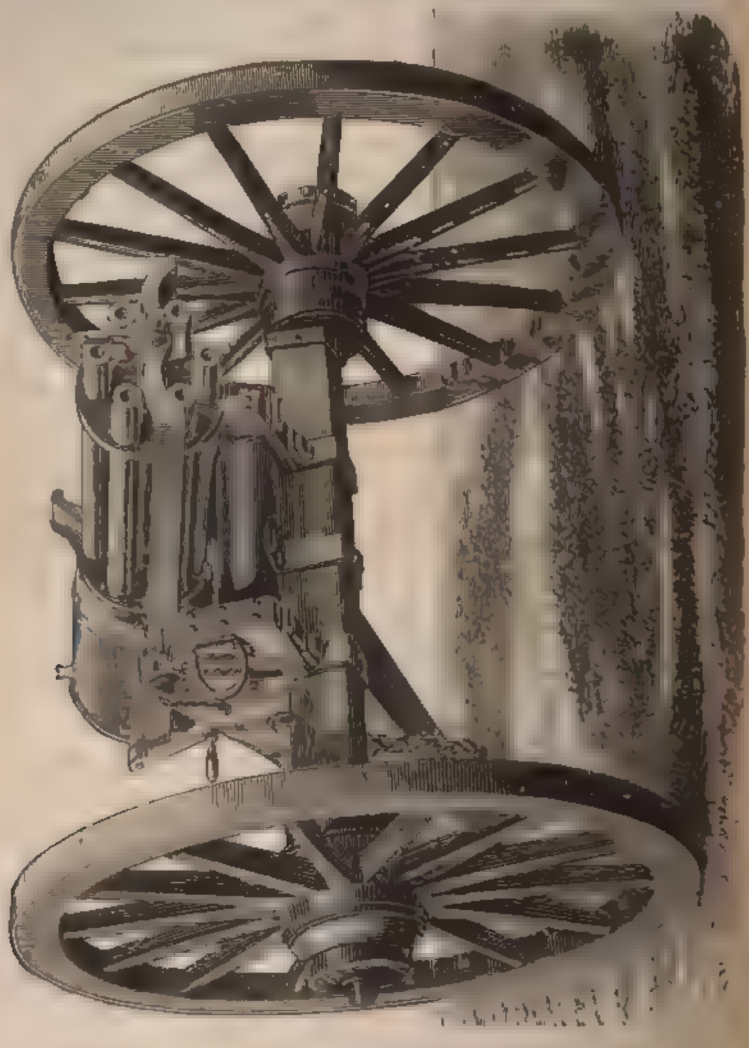
GATLING BATTERY.

The only field-gun in the American section is the "Gatling battery," exhibited by Mr. R. J. Gatling, of Indianapolis, Indiana, and in artillery weapons it is, if not the only novelty, at least the greatest in the Exhibition. Its main features consist of six separate barrels revolving around a central axis, the breech end of the barrels being covered by a stationary metal cyiinder in which the mechanism of the gun works and is protected. The gun is mounted on a field-carriage, with trail of the usual form, and it is secured by the ordinary caps over the trunnions. The breech is raised and lowered by an elevating screw. The revolving portion consists of a lock-cylinder, carrying the loading and firing mechanism. The gun is put in operation by the turning of a crank, but the action and mechanism, though very simple compared with the work performed, would require a somewhat lengthy description and many illustrations. The two batteries exhibited are six-barrel guns, the largest being one inch and the smallest .58 inch bore. They are part of a lot of 100 batteries ordered by the government of the United States from Colt's Fire-arms' Company. This order, it is said, resulted from various trials of the gun made on account of the government. During the present year one of these guns was tried at Shoeburyness, and the following, from *The Army and Navy Gazette*, is a summary of the result:

"The specimen of this gun now brought over to Europe is one of the first made, and is not as perfect and as good in material and workmanship as those which are now being made by the Colt's Company for the American government. Nevertheless, it is sufficient to demonstrate the value of the invention. At the trial, which took place on the 7th instant, before the ordnance select committee, the gun was fired at the range of 150 yards with case shot, and 800 yards with solid shot, giving a good target in both cases. At 150 yards the gun disposed of ninety-six cartridges in one minute and twenty seconds, but as, owing to an accident, one of the barrels could not be fired, twenty of the cartridges dropped out unexploded. The seventy-six effective rounds discharged 1,216 bullets, 668 of which were counted on the target. The strong wind blowing at the time no doubt drove a great many of the light bullets to the right of the target. A second trial of the gun took place at Shoeburyness, last Tuesday, before the Egyptian commander-in-chief his Excellency Chahine Pasha, who wished to acquaint himself with the construction and performance of the gun.

One of the barrels being still unable to explode the cartridges, the fire of the gun was materially impeded thereby. The large bore Gatling gun, if fired with solid ball, is said to make a good target up to 2,000 yards.

The following is a fuller account of the same trial from *The London Standard*, which, with the accompanying engraving, Fig. 1, will give a tolerably fair idea of the nature of this arm and its capabilities:



Gatling battery, Fig. 1

"Gatling's battery-gun is an American automatic machine gun, loading and firing incessantly, the cartridges being supplied from tin feed boxes, from which they are run into a slot in the breech cover, whilst the battery of six steel barrels, secured in position in front and behind by two metal *plates*, is made to revolve by the turning of a handle. The six barrels

discharge metallic cartridges, and have six cylindrical plungers to close their breech ends, each fitted with a horizontal piston or striker, working longitudinally through its centre, to explode by the force communicated by a spiral spring the fulminate in the cartridge. The diameter of the bore of these barrels is one inch; and the cartridges are of two varieties. Both are designed upon the same plan, and differ only in the nature of the projectiles with which they are loaded. A stout copper cylinder, furnished with a rim for the grip of the extractor, forms the case. Across the rear end of the cartridge-case there is an internal iron bar, having a small cell scooped out on one side. This is filled with fulminate, and the bar is held in position by the indentation of the copper case along a line of about a quarter of an inch on each side into grooves at its ends, the fulminate facing the inside of the metallic rear-end of the cartridge, which, in the act of firing, is driven in by the piston upon the fulminate. One variety of cartridge carries a single solid lead shot about two inches and a half in length, and weighing seven ounces and a half; the other is a longer cartridge, closed by a smaller point ball of two ounces weight, but carrying within the case, between the powder and the point, 15 small bullets of 32 to the pound. The solid shot cartridge has a charge of three-quarters of an ounce of powder, and the compound cartridge has the same charge. The Gatling gun was in charge of United States General Love and Mr. Broadwell, and is of a pattern that has been adopted by the American government, 100 having been ordered of Colt's Firearms Company, at Hartford, Connecticut. To convey a brief popular notion of the Gatling gun, one might say that it was an infernal machine, combined of six large needle guns and a Colt's revolver. Such would not be a strictly accurate description, but it would convey a general rough idea. The gun was fired from 150 yards distance, at a frontage of 54 feet of two-inch thick target, 9 feet in height, and in 1 minute and 20 seconds disposed of 96 cartridges. Of these, 76 were exploded, and 20 were miss-fires. The number of missilles discharged by these 76 effective rounds would be 1,216, of which 628 were counted in the targets—namely, 26 point balls through, 443 lodgers, and 159 struck. There is no doubt, however, that the bulletts being light, the strong wind that was blowing carried a good many of them to the right of the targets, and this proportion of what should have been the proper tale was thus eliminated. The penetration, however, was very slight, most of the bullets lodging in the wood, and also being, from the softness of the lead, greatly distorted in shape by their jamming together in the gun at the time of discharge. If the bullets had been hardened as those used in our own service are, and if they had been packed with coal dust or other material to keep them in place, better results would undoubtedly have been attained; as it is, the gun must not be blamed for the defects of the ammunition. Against this Gatling gun an Armstrong 9-pounder field-gun was fired with Lieutenant Reeves's case-shot, the powder charge used in the gun being one pound two ounces, and the shot being eleven to the pound. Seven rounds were fired in the

same time—one minute twenty seconds—and consequently as each case shot contained 68 bulletts, 476 projectiles were discharged. Two of the case-shots, however, passed bodily through the target, and therefore the total of missiles must be reckoned at 360. Of these, 184 passed through the target, 10 were lodgers, and 2 struck. The case-shot used in this instance was somewhat adverse to a fair criterion on behalf of the breech-loader, as Lieutenant Reeves's case-shot of 16 to the pound, with the interstices utilized with buck-shot, would have been more on a par with the numbers and dimensions of the bullets in the Gatling ammunition. The Gatling gun weighs nine hundred weight; the Armstrong 9-pounder, six hundred weight. On a repetition of the firing of the Gatling gun about 12 point balls passed through the target, and there were 416 of the smaller bullets lodged, and 86 struck. This last practice told in the centre of the targets, and gave a very good diagram.

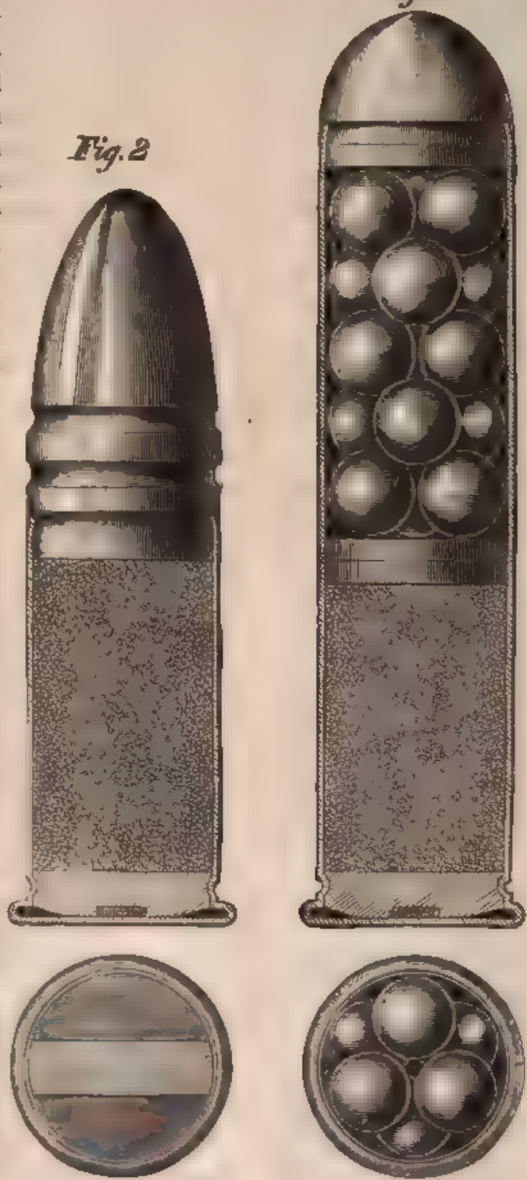
"The Gatling gun was next tried at 800 yards with solid lead shot, going through its 149 rounds in 1 minute and 47 seconds. Of these, 117 rounds were discharged and 32 were miss-fires. It is only justice to say that in these miss-fires are included the cases arising from the dropped cartridges of one barrel, which had its striker broken, as well as those occurring through the fulminates of the cartridges not exploding. Of these 117 shots discharged, 41 passed through the target and 1 struck. All these were driven to the right hand of the target by the wind. Against this the Armstrong 9-pounder at the same range, with a powder charge of one pound two ounces, firing Armstrong field-service segment shells of 41 segments, with percussion fuses, to act on graze, got through four rounds, and all but a fifth, in the same time (1 minute 47 seconds). Seven rounds could probably have been done had not the wind taken the smoke of the discharges directly along the road towards the targets, and thus preventing for considerable intervals the resighting of the gun. The fragments of the shells would in this case add to the number of the missiles, 103 holes were counted in the targets, 37 lodgers, and 31 struck. Without wishing in any way to slight a very ingenious invention, so far as these experiments went, they certainly showed a marked superiority of our own guns and ammunition for field-service. The Gatling gun is, nevertheless, a formidable weapon, and for trenches or a breach, and for street fighting, would do execution; but we doubt if its best effect would be as powerful to check the advance of troops as the bursting of a good shell on the head of a column. Certainly the little amount of recoil, and the consequent advantage of retaining a tolerably accurate direction after being once sighted, might prove a valuable element, and in certain cases would give an advantage not possessed by ordinary cannon, which have to be resighted after each discharge; and which, when the smoke of action is dense, it is simply impossible to do otherwise than by guess."

Figs. 2 and 3 represent the cartridges described in the above extract. *The former* being a full size section of the solid ball cartridge for long

es, and the latter a full size section of the small bullet, or case ridge.

e advantages claimed his gun are rapidity ring, and good prac- also that the gun and age, as compared with ary guns, are so much ier than the barrel h is being fired, there recoil; hence the aim, taken, is not dis- ed. It is also said that n be worked by a small plement of men. The lts, at 150 yards' range, at Shoeburyness in nute and 20 seconds, equal what could be rmed by 30 riflemen good breech-loaders e same time. There le doubt that the rifle t would be more effect han the Gatling half- sphere of lead, at this range, and even at 300 to 500 yards the would doubtless be effective than the hot of the battery. at greater ranges the shot of the battery l certainly be more tive than the rifle bul- There can be little that this weapon sses special advan- for certain purposes positions—such as de- ng flanks, narrow pas- , or bridges, in case of assault. But even with solid shot it will bly be inferior, at ranges over 1,000 yards, to the case-shot, shrap- and segment shell, of such field guns as we have been considering. atling gun, however, should not be compared with breech-loading on the one hand, or field ordnance on the other. It has a special

Fig. 2 *Fig. 3*



Gatling cartridges.

mission of its own, and is likely to have an important influence on future battles—an influence which will materially affect the disposition of troops, the working of field guns, and military tactics in general. Since the trials at Fortress Monroe, it has been adopted as a regular arm in the American army. The gun was taken out of the Exhibition by the order of the French government, and subjected to a series of trials at Versailles,[1] at most of which the Emperor assisted personally, and took the greatest interest in the proceedings. One of the greatest military powers of Europe has lately, and doubtless in consequence of these trials, ordered 100 of these batteries. In the absence of the official reports of these French trials we append a table of one of the Fortress Monroe experiments with the Gatling battery. In the report accompanying it the commanding officer who conducted the trial says: "The moral effect of the Gatling gun would be very great in repelling an assault, as there is not a second of time for the assailants to advance between the discharges."

The following is copied from the official target record of firing with Gatling's breech-loading repeating gun, made at Fortress Monroe arsenal, Virginia, from June 21st to July 7th, 1866, to test its merits with the 24-pounder howitzer for flank defence:

No. of trials.	No. of fires.	Date.	Powder. Kind.	Powder. Weight.	Projectiles.	Elevation, in degrees.	Wind, strength, and direction.	No. of hits on target.	Time occupied in firing.
				Ozs.					
1	73	June 21, 1866	Musket	¼	Buckshot cartridges	0° 55′	M. R. to F.	278	1′ 30″
*2	74	June 22, 1866	....do ...	¼	........do	0° 55′	M. R. to F.	322	1′ 30″
3	101	June 26, 1866	....do ...	¼	........do	0° 50′	C.	691	1′ 30″
†4	29	June 30, 1866	....do ...	¼	........do	0° 30′	M. F. and L.	291	0′ 25″

* Gun oiled and cleaned before firing.

† Three or four seconds lost by reason of defective case.

Kind of cannon, Gatling's breech-loading repeating gun; diameter of bore, 1 inch—6 barrels; weight of piece, 800 pounds; character of rifling, uniform; kind of carriage, wooden field carriage.

GENERAL REMARKS.—Target, 4, 8, 6 feet, in 4 sections of 12 · 6 feet each, placed 200 yards distant from gun. Ground rolling between gun and target. At third trial, target placed 150 yards from gun. At fourth trial, target placed 100 yards from gun.

DESCRIPTION OF CARTRIDGE.—Fifteen bullets, .48 and .50 of an inch in diameter; 2½ ounces lead in one point ball, making in all 7 ounces of lead. Cases made of No. 18 sheet copper; length of case, 4.2 inches; diameter of case, 1 inch; diameter of head, 1.15 inch; weight of case, 1 ounce 272 grains.

CHARGE.—Powder, 3.4 ounces musket powder. Entire weight of cartridge, 9¼ ounces.

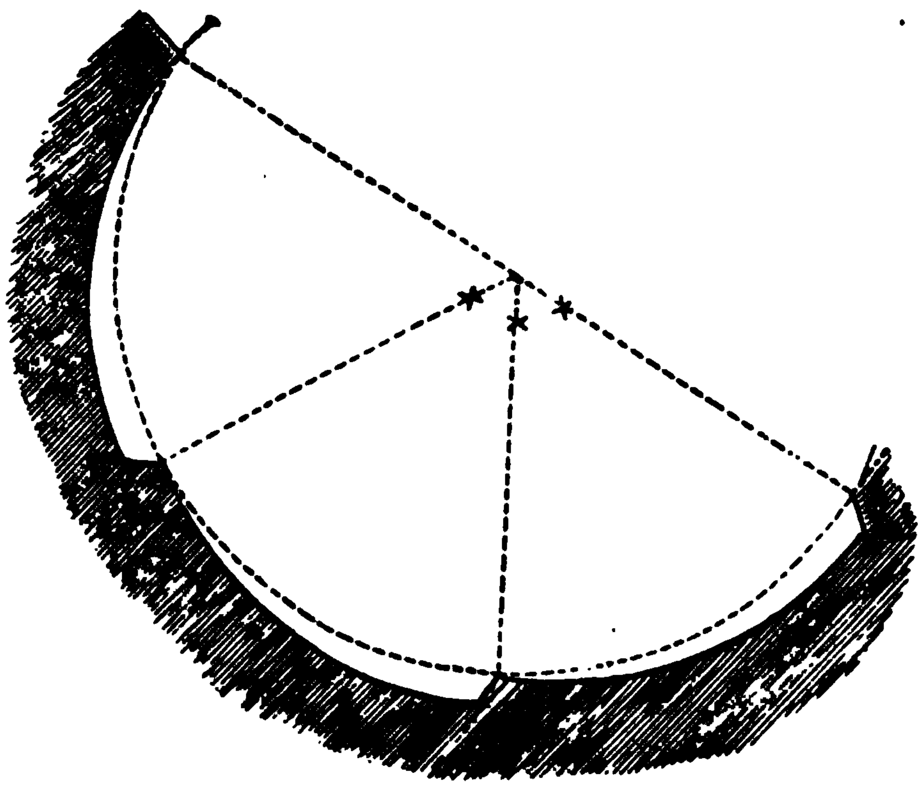
T. G. BAYLOR,
Captain of Ordnance, and Brevet Col. U. S. A., Commanding

AUSTRIAN FIELD-GUNS.

The Austrian government show three field-pieces mounted and highly finished. They are all bronze guns and muzzle-loaders. The largest, which they designate an eight-pounder, looks more like a twenty-pounder.

[1] See Appendix.

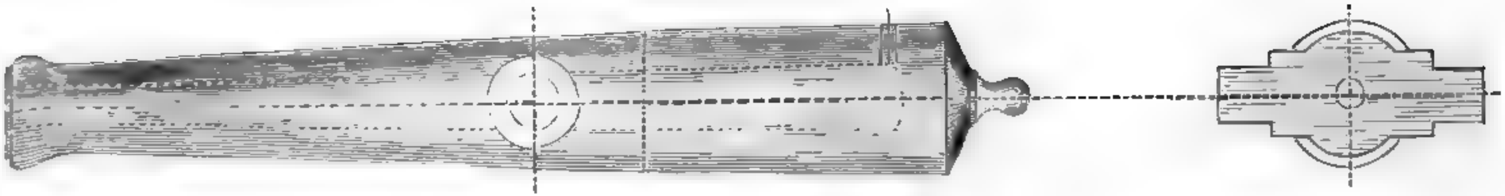
The rifling and equipment of these guns are after the system recommended by the Austrian Committee of Artillery. The rifling is what is termed in England the Scott or saw-shaped system, having a bearing on one edge of the groove only, as represented in the diagram. The twist of the Austrian guns is uniform. The elevation is given by a handle worked outside of the left cheek of the trail. The gun carriage is of wood and has a heavy, unmanageable look compared with the elegant iron carriages of Krupp or Armstrong. The wheels of the carriage and ammunition wagon are, to use a railroad phrase, of broad gauge; which gives great steadiness in driving over rough ground, and also affords space for a large ammunition-box, on which four men can sit abreast. The trail of the gun-carriage is not, as usual, attached to the axle of the ammunition-wagon beneath, but it is kept about level, and rests upon a shelf projecting in rear of the wagon, (to which it is attached by a bolt and lynch-pin,) evidently for the purpose of affording the means for a seat to a couple of men—a very uncomfortable leather-covered seat being fixed on the trail midway between the gun and ammunition-box. A four-pounder, similarly mounted, is shown beside this gun; also a three-pounder packed on and lying lengthwise across a saddle. A second saddle is packed with the carriage and wheels. The carriage, in this instance, is very light and elegant, made of iron or steel, and even with its wheels seems to be a more comfortable load than the gun. The ammunition forms a third load, and all the saddles appear to be intended for heavy horses. These Austrian field-pieces being of greater calibre than the steel guns of the same weight manufactured by Krupp, and used extensively in the Prussian army, will be more effective at short ranges, but at any distance over 1,500 yards they will doubtless be inferior to the steel gun, both in range and accuracy. These qualities, now-a-days, are the grand desiderata in field ordnance. A battery cannot now take up a position, as in days gone by, within half a mile of the foe and calculate upon holding that position against anything save a successful charge by the enemy. The great range and accuracy of modern infantry arms would render their position untenable; so the improvements in small-arms demand corresponding improvements in field artillery.


Rifling of Austrian field-guns.

GERMAN FIELD-GUNS.

Some field guns are exhibited by Messrs. Broadwell & Co., of Carlsruhe. They are steel guns, of uniform polygroove rifling, mounted on iron car-

Fig. 2. Berger steel gun, (muzzle-loader)



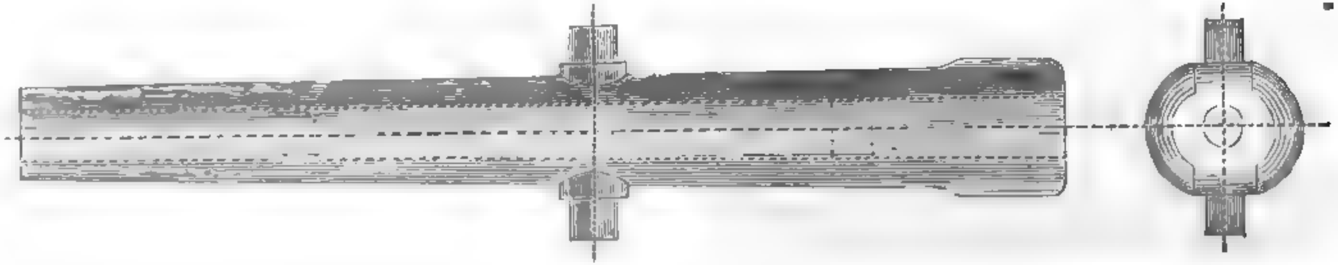


Fig. 1. Berger steel gun, (breech-loader.)

s, and have the wedge breech-loading arrangement generally in use erman guns. To these, in this case, is added the welll-known dwell cap, or expansion ring, and which so effectually prevents the e of gas without requiring a mechanical fit of the breech parts. ring or cap is simply a flat circular plate of iron or steel, having a flange on one side like the cover of an ordinary tin can. This flange nto the breech of the gun next the charge of powder, and the flat ce of the cap or ring rests upon, or is attached to, the breech-block edge. The explosion of the charge expands the flange of the ring, h prevents the escape of gas breechwards, and when the force is nded the flange returns to its normal state. This arrangement, as ave seen, is used by Krupp in some of his guns, and also by er & Co., of Westphalia. Berger & Co. exhibit some good-looking guns, alongside of the more attractive display of M. Krupp. There severe simplicity about these Berger guns, and about German guns ally. The following sketch, Fig. 1, shows the outline of a Berger h-loader on the Broadwell system. Sometimes this extreme simplis departed from, as in the case of the gun shown in sketch Fig. 2, zzle-loader manufactured by Berger & Co. for the government of erland. These guns are about 700 pounds weight each, and 3.35-inch

garding the heavier pieces of field ordnance, there is really nothing e Exhibition calling for special notice except a mounted mortar in British section. It is a cast-iron ten-inch mortar weighing 18 cwt. 5 pounds,) mounted on a solid bed, or block, of timber about five ong, two feet nine inches wide, and eighteen inches thick. This , strongly hooped with iron bands, rests upon an axle limbered in sual manner to an ammunition or shell wagon. This is fitted with s for three horses abreast, if necessary, but two on fair ground are ient to transport the piece. When the mortar is to be fired the ge is unlimbered and tipped up until the rear end of the mortarr block touches the ground; the trail is then raised so as to lift the when the wheels are removed and the mortar carriage lowered to round. The whole operation occupies about a couple of minutes. piece of field artillery is new to the British army. It was not in use g the Crimean war, or even the late Indian mutiny, having been ed into the service only a few years ago. Some handy mortar such is, and a light mountain gun possessing great range, such as Mr. worth's two-pounder steel gun, seem well adapted for Indian warfare e west. The case-shot of the latter especially will deserve more a passing notice when we come to speak of projectiles.

THE FERRIS GUN.

ere is a gun of considerable promise in the Exhibition which has ly been mentioned, and which contains some novel and interesting es of construction. Being at present in the form only of a good-

sized working model, and capable of being adapted both for land and naval service, it may properly be introduced here. The "Ferris gun," exhibited by Mr. G. H. Ferris, of Utica, New York, in class 37, is described in the official catalogue as a "wrought-iron breech-loading rifled cannon." Certainly there is still ample room for a good wrought-iron gun, if such is ever to be made. If England may be said to excel in any branch of the iron trade, it is in the production of heavy wrought-iron forgings; and yet no really reliable wrought-iron gun has been produced in England. The experimental guns of four or five years back have disappeared one by one, and the hospital for incurable cannon at Woolwich is beginning to assume alarming dimensions. While we write we learn from *The Army and Navy Gazette* that one of the 18-ton 10-inch Woolwich guns, said to be rifled on the Lynall Thomas system, has burst at Shoeburyness after a few rounds, blowing the breech explosively to the rear; thus proving that there are exceptions to the "gradual destruction" theory put forth on behalf of wrought-iron guns. Recently a 23-ton 600-pounder gave way, after no more than fifty rounds. The cause of this failure of the Armstrong-Woolwich, or Fraser system of gun construction, may engage attention in a more special manner in connection with battery and naval ordnance. We were led to refer to these failures now, because the Ferris system of construction seems to provide a remedy for such apparently inherent defects in wrought-iron cannon. Before adverting to what we regard as the most important point in the construction of the Ferris gun, the following remarks from "Greener's Gunnery" will illustrate the evil which this system seems destined to cure:

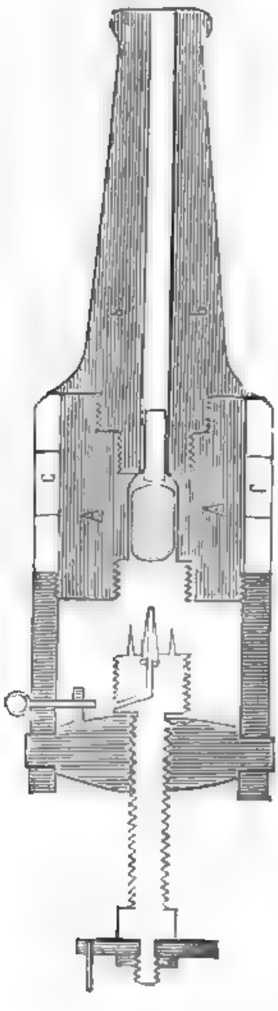
"Professor Barlow, many years ago, proved to the satisfaction of the Institution of Civil Engineers, that the metal in any cylinder decreases in utility in proportion to the square of its distance from the centre; that the outside of a gun of the form now used, in fact, is only one-ninth as useful as the inside, being three times as far from the centre. If we double the thickness, the outside, being five times as far from the centre as the inside, will be but one twenty-fifth as useful, or, in plain English, nearly useless. The reason of this is simple, and I will endeavor to explain it. A bar of cast iron, one inch thick each way, and forty inches long, will stretch about one-twentieth of an inch if a weight of about four tons be suspended by it. When the weight is removed, the cast iron nearly recovers its previous form, and is uninjured, but if it be stretched more by a greater weight it is permanently injured. A bar of the same thickness, but three times as long, 120 inches, will stretch three times as much, or three-twentieths of an inch, with the same weight; or if only one-third of the weight, one ton and a third, be suspended, it will stretch one-twentieth of an inch, the same as the shorter bar. If we suspend sixteen tons by four bars one inch thick and forty inches long, they will each stretch one-twentieth of an inch only, and remain uninjured, but if we attempt to do so with two bars forty inches long, and two 120 inches *long*, then, when the whole have lengthened one-twentieth of an inch, the

short ones are exerting a force of eight tons, but the long ones that of only two and two-thirds tons. The weight, therefore, will still further lengthen the bars, and permanently injure the short ones; perhaps break them first and then the long ones. This is the way a gun is burst. The inside is a series of bars of iron, say forty inches long, in the form of a ring, the outside a series of rings, representing the bars three times as long."

To bring these several bars or rings to bear their fair share of the strain, Mr. Ferris forms the core of his gun of concentrated wrought iron rings, disks, or washers, of different qualities of iron, the softest inside, and forged around a small mandril or centre, which is afterwards all bored out in boring the gun. Each ring or washer, however, as it is made, has a mandril with very little taper driven into it until its outer circumference begins to enlarge, by which means the entire ring, or washer, is brought to support its share of the strain. The following description of the gun and its manufacture is extracted from documents furnished by the inventor, and Mr. Macomber, who represents him in Paris, to the United States government. The chief features of the gun are summed up thus: It is manufactured of wrought iron and steel; it is a chambered gun; diameter of bore one inch and three-quarters; spherical ball to fill bore weighs ten ounces; smallest sized conical ball twenty-seven ounces; full capacity of chamber in powder twenty-seven ounces; average diameter of a cone-shaped chamber, two and seven-eighth inches; length of the chamber, seven and a half inches; whole depth of bore thirty-one and a half inches; distance the ball travels in bore, twenty-four inches.

Our woodcut on page 82 represents a 100-pounder on the Ferris principle on a scale of three-eighths of an inch to a foot. The bore of this gun would be six inches, and the charge of powder 50 pounds, which Mr. Macomber believes would give an initial velocity of 2,200 feet per second, and at 35 degrees elevation, send a shot or shell ten miles. The chamber and barrel of the gun, A, *b*, is of wrought iron, hooped with the steel rings C. "Mr. Ferris," says our authority, "has built the barrel of his gun of the best wrought iron bars, all welded together, the softer at one end, and growing harder towards the other end; then coiled into the form of a watch-spring, then hammered into a flat washer-like ring, the softest iron forming the inner and the hardest the outer circle of the same. These rings are passed through rollers and brought to a uniform thickness and an even surface. They are then laid together around a mandrel bar, forged and thoroughly welded together, with heavy longitudinal and light vertical hammering, until a solid mass is formed, which, after being bored, chambered, rifled inside, and perfectly engine-turned outside with a true taper from the breech to the muzzle, forms the core or heart of the barrel. The covering of this core is formed by a series of heavy steel rings, mechanically turned, inside and outside, and the inner surface made to exactly fit the core, the larger at the breech and the smaller at the muzzle, the rings being firmly secured in a peculiar manner

to prevent loosening by the concussion of the discharges. The steel rings are lubricated and forced into their places by a screw and clutch, and they can be removed by the same means, two or three men easily working the screw. The breech-chest is of wrought iron, and attached by heavy flanges and bolts. Through the breech-chest the screw plunger is worked by a double screw, and driven in the rear by a bar-wheel, five turns of which by the gunner will leave the chamber open for the insertion of the shot and charge, and the like number of turns drive up and secure the same. The upper end of the plunger is fitted with detachable steel plates, so arranged as to exactly fit the chamber of the barrel, and being bevelled at the end, they cut away all fouling of the chamber, being bolted to a metal plug which, firmly entering the base of the chamber, forms with the slot-plates a perfect prevention of the escape of gas."



The Ferris gun.

TRIALS OF THE FERRIS GUN.

The following refers to the several trials of this gun made in America before it was sent to the Exhibition: "On February 25, 1863, we tested the Ferris gun on the frozen surface of Oneida Lake, in Madison county, New York, firing at a target at one thousand feet measured distance, and in repeated experiments found the fall of the shot to be four feet six inches from the gun level in that distance."

"May 29, the first trial of the Ferris gun was made at the navy yard, Washington, in the presence of the President.

"*Record of shots for range.*—At four degrees elevation, 2,850 yards; at four degrees elevation, 2,750 yards, weight of ball two and three-quarter pounds, powder twenty-four ounces. At the trials for penetration, June 16, 1863, the following results were obtained:

Ferris gun.		*Muzzle-loader.*	
Distance	50 yards.	Distance	50 yards.
Weight of ball.........	3.71 lbs.	Weight of ball.........	3.71 lbs.
Weight of powder......	24 oz.	Weight of powder......	4 oz.
Penetration, wrought iron	3 in.	Penetration...........	½ in.

"By a general order from the ordnance department, June 23, signed by General Ripley, the Ferris gun was removed to West Point to test

the initial velocity." At the first trial the initial velocity was 2,200 feet per second.

"Under the general order of June 23, the gun was taken to Fire Island as the most suitable place for range firing. August 1, the trial was conducted by Mr. Macomber and the inventor. This firing was kept up at intervals, when the weather would permit, till September 4, and was witnessed by many scientific and practical military men, with the following results: Elevation thirty-five degrees, weight of ball three pounds, powder twenty-four ounces, distance nine miles."

This gun, after 147 rounds, is as perfect in all its parts as when taken from the workshop. The inventor, and his representative at the Exhibition, believe "That a cannon built on this system, with a chamber having capacity for fifty pounds of powder, could project a shot of 100 pounds weight through at least twelve inches of solid iron, and if the gun was elevated to thirty-five degrees, that it would throw a shot or shell ten miles." The weight of such a gun would be from eighteen to twenty tons; diameter of bore six inches, and size of chamber ten by eighteen inches.

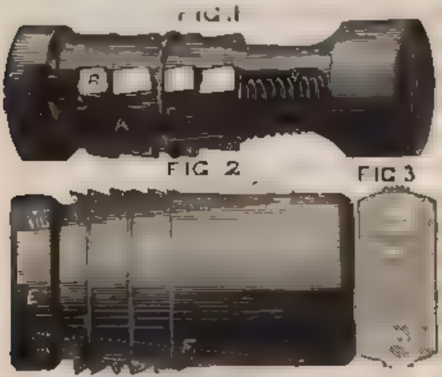
It is much easier to conceive that a shot having an initial velocity of 2,200 feet per second from a gun elevated 35° might have a flight of 9 or 10 miles, than that a 6-inch projectile of any known metal could penetrate a 12-inch solid iron plate. Work sufficient to accomplish such a result might possibly be stored up in a projectile of 100 pounds weight. But can any metal be found *hard* enough and *tough* enough to stand the shock of conveying this work to the plate without the shot itself being broken up or distorted? If the penetration of a 12-inch plate by a 6-inch shot be only the dream of a sanguine inventor, there is no doubt about the nine mile range of this model gun—a gun that can throw its shot and shell into a city, the inhabitants of which can neither see the smoke nor hear the sound of the firing.

An article in "Bradshaw's Hand-Book of the Paris Exhibition" concludes, "such is this remarkable implement of destruction, which seems calculated to effect as great a change in the art of gunnery as printing in literature." The Ferris gun may not be all that this sentence implies, and it may, like many other inventions, come short of the inventor's expectations, but unquestionably it contains the elements of a more *reliable* system of constructing wrought iron guns than has yet been produced—a system which deserves, and will doubtless receive, attentive consideration.

CANNON DESTROYER.

Near the Ferris gun lies a "Cannon destroyer," invented and exhibited by M. A. Bonzano, of Detroit. The following brief description of this invention was, during the war, published in the scientific journals of our own and other countries. The main portion A, consists of wrought iron. This is turned and grooved on three sides to receive the serrated slides B. These slides are held in place by wire C, slipped over them, and by

being fitted in tapering grooves will accommodate themselves to wide ranges of calibre. The springs D, *give*, as the spiker is pushed in, butt-end first, or with the teeth protruding towards the muzzle. These teeth have a sharp rake or angle outwardly, so that the least attempt to pull the instrument out, causes them to cut into the bore and jam fast. The tapering form of the plug A also serves to wedge the cutters out so that its sticks tighter with every attempt to dislodge it. Figures 2 and 3 represent a spiker for guns of large calibre; parts on the side are cut away so as to make it lighter and easily handled by one man, and the forward end E is of hardened steel, so that it cannot be cut or drilled out; the dotted lines F show the position of the cutters when the temporary wire is broken and they are pushed back. These spikers can be kept ready for use in the caissons. At the trial of this invention the spiker was inserted in a 6-4 inch gun; a bag of eight pounds of powder was previously put in the gun. The explosion moved the spiker two and a quarter inches forward, where it lodged, the gas going out at the vent and past the spiker. The gun was subsequently removed to the machine shop, where every attempt to remove the spiker from its position failed. The trial took place at the Washington navy yard.



Cannon destroyer.

THE MACKAY GUN.

The Mackay gun, which held out so much promise a year or two ago, is again attracting a good deal of attention. Though not in the Exhibition, it should not be passed by in silence. With the Ferris gun, its proper place at present seems to be midway between field and heavy ordnance, with a tendency towards the latter.

The projectile—the immediate instrument of destruction—is held by artillery authorities to decide the nature and conditions of the gun, and Mr. Mackay's projectiles are of the simplest description, being merely smooth cylindrical bolts. The interiors of the guns are furnished with spiral grooves, and the gases escaping up these grooves communicate a rotary motion to the projectile. The advantages secured are that, with less strain upon the gun and less weight of charge, there is a greater initial velocity, and greater penetrative power and range. The projectiles are made of one hard metal, incapable of expansion in the bore of the gun. They may be cast, and afterwards turned or not, as may be deemed necessary, and the absence of studs, buttons, or bars, for the purpose of giving a rotary motion, renders them cheaper of construction than other *elongated* projectiles. Mr. Mackay contends, and cites his experiments

in proof, that an elongated projectile proceeding from the windage gun at the initial velocity of 1,400 feet per second is immensely more destructive than a similar projectile without rotation with a flight of 1,600 feet per second initial velocity. He believes it is not possible to obtain the advantage of such a rotation upon the fixed projectile system, because the strain on the gun would be so great as to destroy it with a heavy charge; and even if the rifled gun stood a few rounds, the penetrative powers of the projectile, after it becomes dientangled from the fixed screwing process, would be very slight. He claims that his experiments have established that the force or striking power due to rotary projectiles, and the quantity of powder used for the charge, can only be obtained when the mean of rotation is imparted to it to coincide with the initial velocity.

At a recent trial of these guns, near Liverpool, there were three guns tested—one 8-inch, one 6-inch, and one 3-inch. The targets were four in all. No. 1 an 8-inch target, solid iron plating, resting on two flat balks of timber, 14 × 14, kept in its position in front and rear by two pieces of battens nailed, and supported at the top by a 14-inch balk which took in the head of the plate. No. 2 was the Agincourt target, a 5½-inch plate of rolled iron, backed with 9-inch teak, iron skin, resting on 14-inch balks, and kept in position by two other balks being braced to them. No. 3 was a 5-inch plate supported on both its edges by 14-inch balks. No. 4 was a 2½-inch plate.

The first shot fired was a solid cast-iron shot of 70 pounds, which was fired at a distance of 75 yards, from the 6-inch gun, with a charge of 22 pounds, against the 5-inch plate. The velocity may be estimated from the fact that it passed clean through the target, making a circular hole. Portions of the broken shot, and a large piece of the target, were picked up at the distance of 1,000 yards (?) in a direct line from the target.

The next shot fired was from the 8-inch gun at the same target with a spherical steel shot of 68 pounds, with 30 pounds of powder. It struck the target low down to the right, but the penetration was complete, and a large portion of the back of the plate surrounding the aperture was carried away.

The third shot fired was a cylindrcal steel bolt of 74 pounds weight, which was fired from the 6-inch gun against the Agincourt target, with a charge of 22 pounds of powder. This shot struck the target in its strongest part, and had it remained whole there is little doubt that it would have made a clear penetration. As it was the shot broke into two parts, one of which dropped in front of the target, and the other, though it went through the plate itself, lodged in the backing.

The fourth shot was a cast-iron cylindrical bolt of 70 pounds, with a charge of 22 pounds of powder from the 6-inch gun against the Agincourt target. The penetration in this case was not complete, but extended for two-thirds of the width, cracked the plate, and seriously damaged the backing.

The fifth shot was a spherical steel shot, fired from the 8-inch gun,

with 20 pounds of powder, at the 5-inch plate. The plate was completely punctured, and a large amount of the metal and backing carried away.

The sixth was of the same character, with 16 pounds of powder. It struck a perfectly firm part of the same target, through which it passed with equal success.

The seventh was a 70-pound cast-iron spherical shot, fired at the 5-inch plate, from the 8-inch gun, with only 14 pounds of powder. It struck the target to the right hand, close to the edge, and carried away bodily a mass of metal weighing at least two hundred weight.

This finished the first day's firing, the above account of which and what follows was reported at the time in *The London Standard:*

"On Friday morning the experiments were continued in the presence of Major Kleiker, of the Swedish embassy, and other gentlemen. The 6-inch gun, it will be remembered, was on Thursday fired at the Agincourt target, but the steel bolt did not penetrate beyond the backing. Mr. Mackay, in accounting for this, said that on the following morning he would send a bolt through. Accordingly on Friday morning he loaded the 6-inch gun with 25 pounds of powder, and a steel bolt of 82 pounds, by Firth & Co., of Sheffield, and directed it at a part of the Agincourt target which was still intact. The effect was tremendous; the bolt cut a clean hole through the front of the target, and tearing through teak, backing, skin, and all, was picked up 86 yards beyond, while a huge fragment of the target, weighing no less than 385 pounds, was found at a distance of 290 yards beyond the target. The next shot was from the same gun, with a similar charge, and was directed at the 8-inch solid plate. The plate was not quite firm, and 'gave' a little. The penetration was, nevertheless, fully seven-eighths, and the plate was bulged and cracked from top to bottom."

The 3-inch gun tested for range at high elevations attained only the moderate range of 6,000 to 7,000 yards, (a range inferior to that of the 15-inch Rodman smooth-bore at Shoeburyness with round shot,) which was less than the great penetrating power of these guns would lead us to expect. The men who have served the Mackay gun complain that it is very hard work to get the shot home; but this, and doubtless other defects, could be got rid of, if only a tithe of the money spent on the Woolwich guns were spent on this. But whether Mr. Mackay's gun will overcome all the evils supposed to be inherent in rifled ordnance, remains to be proved. It has, however, done enough to entitle it to a full and fair consideration from all who are interested in the improvement of field or heavy ordnance.

CHAPTER IV.

HEAVY ORDNANCE.

ART AND SCIENCE OF DESTRUCTION—IMPERIAL ARSENAL AT RUELLE—SELECTION OF MATERIALS—TREATMENT OF ORES—FRENCH NAVAL GUNS—BREECH PLUG FRENCH 40-TON SMOOTH-BORE—REINFORCE RINGS—ERICSSON GUN—CANADIAN ORES—RODMAN GUN AND 8-INCH WARRIOR TARGET—FRENCH RIFLING—BRITISH 600-POUNDER—FRASER GUNS—SHUNT GUN—WOOLWICH GUNS AND PALLISER SHOT—ACCURACY—KEARSARGE AND ALABAMA—ARMSTRONG 12-TON GUN—WHITWORTH GUNS—RIFLING—LINING CAST-IRON GUNS—KRUPP'S STEEL GUNS—KRUPP'S 1,000-POUNDER—BERGER'S GUNS—SWEEDISH GUNS—SUMMARY.

ART AND SCIENCE OF DESTRUCTION.

A few days before the closing of the British Parliament this year (1867) John Stuart Mill, in referring to the "Treaty of Paris of 1856," stated that, "Twenty years ago a French writer remarked, that though the *art* of destruction was easy, yet the *science* of destruction was standing still, and bore no proportion to the activity of the other sciences, particularly the science of production. But what would the philosopher see now? He would see the inventive genius of mankind lending itself to the task of destruction, and bringing forward year by year more destructive engines to blast into atoms whole hosts of human beings, as well as the defence to which they trust. But ten years were passed in profound peace. Commercial intercourse, which we were in the habit of believing was the great safeguard against war, had been extended with the doctrines of free trade all over the world, and protectionist opinions, which were calculated to render commerce provocative of war, had been discouraged all over Europe. And yet we were now engaged, not in diminishing, but in greatly increasing our naval and military establishments. Our warlike expenditure was now twenty millions more annually than what had actually been the expenditure in the time of the present generation."

If France, by the construction of "La Glorie," induced Britain and other countries to build ironclads sooner than they otherwise would have done, on the other hand, the late American and Prussian wars, combined with the English experiments at Shoeburyness, showed France the necessity of manufacturing heavy ordnance and breech-loading small-arms. When the Exhibition of 1867 opened, France, doubtless regarding it more as a peaceful display, made no show of heavy ordnance, and it was not till July, when a comparison with other countries put the French war material in the shade, that the government finally determined to make up for lost time, and brought out their largest and best guns. Indeed, it is generally believed that some of the biggest of

the guns now on the banks of the Seine under Bessemer's steel bridge were manufactured since the opening of the Exhibition. But while such facts illustrate the productive capacity of the imperial factory at Ruelle, they suggest a want of fairness to other exhibitors, who were required to complete their arrangements by the 1st of April. The Imperial Commission, however, have taken the sting out of this seeming unfairness, by the liberal extension of similar privileges to others. If the French heavy ordnance appeared at a late period of the Exhibition, we shall only say "better late than never," and on the principle that the "last shall be first," we shall proceed at once to examine these late but welcome additions to the Exhibition of 1867.

IMPERIAL ARSENAL AT RUELLE.

The heavy guns for the French army and navy are chiefly manufactured at Ruelle, a town near Angoulême, on the main route from the latter place to Limoges. The selection of this site for the erection of workshops for this purpose was due to two principal causes: First, the great hydraulic power derived from the river Louvre; and, second, the proximity of particular ores, which produced castings evincing a more than ordinary degree of resistance to the action of gunpowder. The vicinity having extensive forests, also affords an ample supply of excellent charcoal, the only description of fuel allowed to be used in the metallurgical operations connected with naval artillery. Ruelle, first converted into a cannon foundry by the Marquis of Montalembert, became a government arsenal in 1776. For a long period, even under the government, the foundry was carried on in a very primitive manner. The cannons were run on the first melting in earthen moulds; they were sometimes cast with cores, and sometimes solid; in the latter case they were bored by means of a machine invented by the original owner, M. Montalembert. At length the crisis arrived when France was imperatively called upon to take prompt and active measures in connection with her naval artillery, and to obtain as soon as possible 6,000 pieces of ordnance. The establishments capable of contributing to the great national want were closely examined; intelligent emissaries were despatched all over the kingdom and elsewhere, and Perrier, Hassenfratz, and Monge published works on the art of manufacturing cannon. The foundry at Ruelle was entirely remodelled; two reverberatory furnaces and new casting-shops were added; tools and appliances of a more modern construction replaced those hitherto in use, and the works were conducted under the immediate superintendence of the state. Until the year 1823 the cannons continued to be cast after the first melting, but after that period a less primitive method was adopted. The canals and general distribution of the water-power and supply underwent considerable improvements. In 1840, the operations of bronze casting and boring, originally carried on at Rochefort, was transferred to Ruelle, and in 1846 a chemical laboratory was attached to the premises. Be-

tween this period and the present, the alterations and additions have been incessant, and similarly to Creusot and Essen, Ruelle grows larger every day, and blocks of stone, masses of béton, and the different elements of construction lying here and there, bear witness to the transformation in progress.

MATERIALS USED AND THEIR PREPARATION.

The greatest care is bestowed on the selection of materials at Ruelle, which may be classed under the following heads: charcoal, coke, coal, moulding sand or loam, fire-brick and burr, castina or flux, iron ores and pigs. The charcoal delivered for sale at the foundry of Ruelle must be totally devoid of moisture, the existence of which is discovered by weighing samples selected from the quantity to be purchased. A certain number of cubic feet of material, packed pretty close, is weighed, and if the average weight exceeds 20 pounds per cubic foot, the seller is obliged to make a deduction on the usual price.

Coke is employed for a variety of purposes in the establishment. The furnaces, which are constructed on Wilkenson's principle, are fed with it, and it constitutes one of the elements in the composition of the crucibles; it is also pulverized and used in the moulding shops, and forms an ingredient in the manufacture of various iron cements. Especial care is taken to insure it being of the best quality, and the surveillance is of so stringent a character as to deter any one from offering it for sale unless fully convinced of its excellence. All substances of a sulphurous nature are particularly condemned, and the coke must not be too porous, too much burnt, too soft, or too brittle. Formerly all the coke was procured from England, and the price, delivered at the foundry, was on the average 52*s*. the ton. Latterly coke of an excellent quality at a much lower price has been obtained from Aveyron, where they also obtain coal considerably cheaper than it could be imported from England.

A considerable variety of iron, so far as quality is concerned, finds its way to Ruelle, for, although a large proportion of the metal run for the manufacture of cannon consists of pigs made from the ore on the premises, yet formerly these latter were supplied by the neighboring furnaces, Jaumellières, Chapelle, and La Motte. Recently some importations have been made from Alélick, in Algeria, of gray pig-iron, possessing an extraordinary degree of tenacity and toughness. These qualities are indispensable, since all white, hard, and brittle iron would give very bad results. The contractors despatch the pigs, having a weight of four hundred weight, to the foundry, where they are broken, and the nature and appearance of the fracture at once determine their acceptance or rejection. Those which pass this preliminary inspection are further tested by being employed in the casting of a cannon which is subsequently proved *á outrance*. To insure the iron admitted to the premises possessing the qualities required, 55 per cent. of it is fused along with the quantum necessary for running a cannon of certain dimensions. The

cannon being cast, it is subjected to the following proofs: The first trial is made with one shot and a charge of two and three-quarter pounds of powder, fired 20 times in succession; the next with two balls and a charge of four pounds and a half of powder, fired the same number of times; and the third with three balls and the same charge of powder, fired 10 times consecutively. After withstanding this test it is further proved by being fired five times with six balls and a charge of nearly nine pounds of powder, and subsequently with a charge of 15¼ pounds of powder and 13 balls fired the same number of times.[1] This last test is repeated 10 times, and if the piece stands it without evincing any symptoms of weakness the iron is accepted; but if it should give way during the trial the iron tendered is not merely rejected, but the tenderer is obliged by his agreement to defray the cost of testing.

After the ore has been examined and accepted it is spread out upon the ground, and the earth and residue of the matrix adhering to it carefully separated; and to effect this operation in the most complete manner, every lump bigger than a nut is broken in pieces. It is then allowed to remain exposed to the air for a time long enough to permit the small traces of sulphur to be dissipated, and the combined influences of the air and rain remove nearly all vestiges of any magnesia that may be present. This process is termed maceration; and although in order to carry it out it is necessary to have always a large stock of ore on hand, yet it is considered so important a measure that the former condition is unhesitatingly complied with by the managers of the establishment. The maceration accomplished, the mineral is washed in circular troughs, through which a stream of water continually passes, and in which paddles fixed upon a vertical shaft maintain an incessant agitation. By these means all foreign substances not yet detached from the ore are effectually removed. It is subsequently dried and piled up in heaps, consisting of horizontal layers of a certain thickness, which are cut through vertically when the wagon comes for a supply for the blast furnaces. An average quality of all the iron obtained from the different mines is thus made use of, as the layers, 14 in number, composing the heap, are arranged so that no two successive should consist of iron brought from the same locality.

The manner of charging the furnaces at Ruelle is very simple. An inclined plane, with rails laid down upon it, carries a small truck which is drawn up the incline by an endless chain worked by one of the waterwheels on the premises. Alternately with the ore charges of charcoal and casting are tipped into the furnace. Nine men constitute the working staff attached to each furnace, of which five are intrusted with everything connected with the charging; two of the above number have the care of the blast and the pipes; one performs the duty of clearing away the cinders and ashes, and another prepares the moulds for the run-

[1] "The proof of the Armstrong guns is two rounds with service charge and shot, and three rounds with service shot and a charge of one-sixth of the weight of the shot."—*The Engineer.*

ning of the metal. These operations are carried on night and day, and a special dormitory in the vicinity of the furnaces is appropriated to the use of the men who have charge of them. The process is always conducted with the view of obtaining pigs more or less gray and spotted; and one of the means of ascertaining outside what is transpiring inside the furnace is by a careful inspection and examination of the dross or *scoriae*. The results of the inspection are both curious and interesting, especially to metallurgists. The colors of the *scoriae* present, at different stages of the melting, almost all the varied hues of the rainbow, but those generally observed are violet, bright green, neutral and deep green, inclining to black occasionally. A persistent violet tinge is a sign of a grayish flocky metal, and distinguishes the commencement of the fusion; this is a defect, and probably arises from an insufficient amount of blast power. When the tint is bright green, a clear gray iron is the result, and when it passes to a neutral or deep shade, or preserves that shade for some time, the produce of the furnace has a spotted appearance. The presence of a very dark green approaching to a black hue is a certain indication that the pig will be white. By altering the proportions of ore and castina, or by modifying the blast, the colors of the *scoriae* can be changed at pleasure; but previously to adopting any regular and fixed method, the results of the former running are carefully examined, in order to be certain that harm, instead of good, might not arise from any fresh interference. The pigs produced in the blast furnaces on the premises are, similarly to those purchased elsewhere, broken up, carefully examined, and classed according as they present a lighter or darker color and varieties in the nature and appearance of the fracture. These home-made pigs, so to term them, constitute 40 per cent. of the different mixtures used in casting; 20 per cent. is supplied by pigs of a second melting, and the remaining proportion by those obtained from the neighboring workshops. A scrupulous attention is paid to the exactitude of these proportions; only assistants of great experience and judgment are allowed to examine the qualities of the respective pigs, to class them, and to superintend the operation of depositing them, in separate charges, near the opening of the furnaces ready for instant injection.

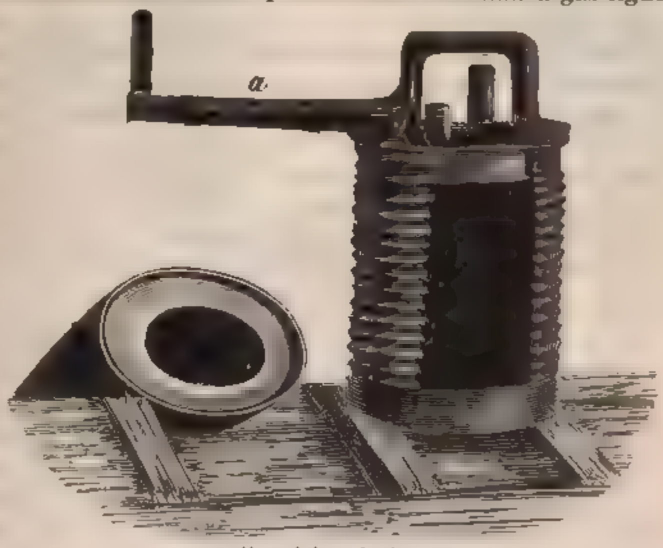
Coal is the combustible employed in heating the furnaces, the flame of which runs along the ceiling and passes over the pigs, which are so arranged that the largest receives the greatest amount of heat. At Ruelle the practice is to carry on the heating very rapidly and energetically, so as to effect the fusion with the greatest possible despatch. One advantage of this method of proceeding is that the metal is endowed with an extreme fluidity, and all the *scoriae* is disengaged and floats upon the surface; moreover, it takes a longer time to cool, and its tenacity is thereby considerably augmented. About two hours is the time usually occupied by one melting.

FRENCH NAVAL GUNS.

The French cannon, like our own, are cast upon the core system. Solid cores of iron are used prepared with moulding sand and loam in the usual manner. As the cannons cast at Ruelle are all breech-loaders and hooped, the difficulties formerly attending the preparation of the breech and trunnion moulds are obviated. The moulds finally being in position are connected at the bottom, and at different points in their height, with the channels leading from the furnaces, by means of iron pipes coated in the inside with fire-clay. The metal enters the mould by the lowest orifice, and rising within it, carries the *scoriae* upon the surface, which again is raised higher by the arrival of the metal at the next orifice. A registry of the exact time during which the operation lasts, and the manner in which each furnace contributes to the general running, is carefully noted so as to serve for reference on future occasions. For some time past the method of casting the cannons at Ruelle with the breech downwards has been discontinued, since it is now generally admitted that the densest part of a long cast-iron cylinder is not, as would naturally be supposed, at the end occupying the lowest position in the mould, and consequently supporting the weight of the superincumbent fluid, but at a point somewhere about the middle of the length. This statement has been confirmed by experiments made in Sweden.

The French naval guns consist, chiefly, of four sizes, viz: 6½-inch, 7½-inch, 9½-inch, and 10¾-inch. The latter has not, as yet, been generally adopted in the service. These cannon are not of one homogeneous metal, like Krupp's, or the largest American guns, but consist of a core of cast iron with a reinforce of steel hoops. They are all rifled breech-loaders. At first only a single series of rings was put on, but it was found that notwithstanding every effort to hide the joints, they invariably opened after a certain number of rounds in quick succession had been fired. The present plan is to put on a double series of steel rings, one over the other, so as to break joint. These rings are made of puddled steel, and are chiefly supplied by MM. Petin, and Gaudet of St. Chamond. Their thickness varies from two to four inches, according to the calibre of the gun. The breech is closed by a screw of 15 or 16 threads cut into the metal of the gun, into which is screwed a plug of steel. Were it necessary in firing to screw and unscrew the whole length of this plug at every round, much time would be wasted. This difficulty is obviated by the invention of an American, Mr. Eastman, which will be better understood by referring to the accompanying woodcut. This screw, or breech-plug, is a cylinder of cast steel, upon the surface of which threads have been cut. The screw is then divided into six equal parts, in three of which the threads are removed, both from the plug and the breech of the gun. When the breech is to be closed, the threaded portions of the plug are presented, so that they come opposite the smooth parts of the hole, and *vice versa*. The stopper is then pushed in, when a third of a turn with the

handle *a* brings the screws of both parts together. It is evident, however, that this operation could never produce and maintain a gas-tight joint, so the front of the plug is furnished with a ring *b* capable of revolving freely on its axis, and to which is attached a cup, or Broadwell ring, which is composed of the softest description of steel. The elasticity of this ring permits its flange to expand and be compressed against the bore of the gun, thus preventing the escape of gas. These rings, or cups, which sustain the first and worst of the shock, are often placed *hors de combat*, but they are easily renewed. The weight of the breech-plug for a 9½-inch gun is 500 pounds, consequently some arrangement had to be devised for the purpose of supporting and guiding it. The mechanism consists of a bronze frame, attached, or rather hinged, to the side of the breech of the gun, in contiguity to the opening. This frame carries a bracket, which has a kind of gutter, in which slides the screw portion of the plug. When the frame is swung back to the right, it carries the plug or stopper (previously drawn out of the breech) clear of the opening in the rear of the gun. To facilitate the introduction of the shot, weighing for a 9½ inch gun 320 pounds, a small iron platform or tray is attached to the under side of the breech, and by this arrangement the envelopes of the cartridges are prevented from being torn by the threads of the screw. The platform is constructed with a groove intended to guide the shot in the right direction, and is sufficiently long to allow both shot and cartridge to pass, not only the threads of the tapped portion of the breech, but also the part where the plug and the powder are placed. In the older plan the iron tray was fixed to the bracket, but in the hinge system it is independent of the rest of the apparatus, and is run in and out by hand.



French breech-plug.

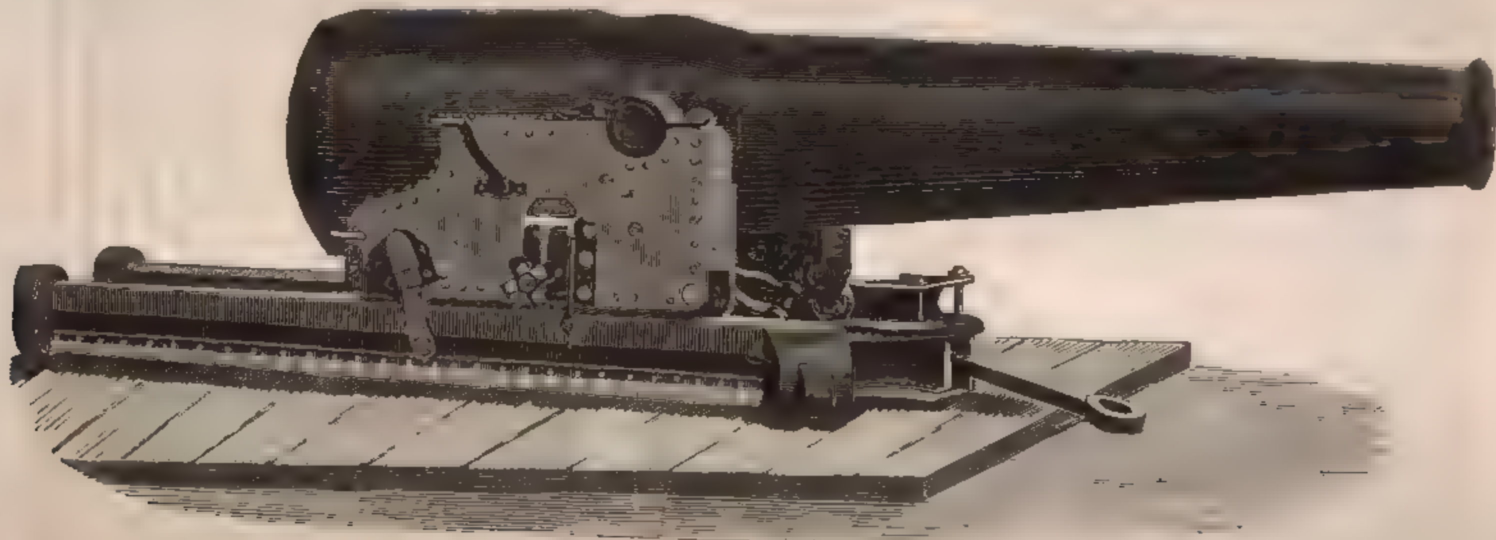
The French authorities, and their exponents, whose descriptions in *Les Grandes Usines* we have partly adopted, consider the above method of closing the breech superior to the block or wedge system of Krupp. The sides of the breech are not weakened as in Krupp's guns, but, on the other hand, the through block or wedge of the latter is better calcu-

lated to inspire confidence than a shallow screw thread cut in cast iron. There is also the danger of this screw being left unturned, or only partially turned.

"This neglect," says our authority, (as translated in *The London Mechanics' Magazine*,) occurred on board the Montebello, and the results, as can be readily imagined, were both serious and fatal. It was at first supposed that the stopper had been properly inserted and screwed up, and that the accident was due to the violence of the charge, which had proved itself too strong for the holding power of the screw, and it is needless to say that those who had served the gun persevered in this opinion. But, unfortunately for their veracity, a series of experiments was at once undertaken to test the fact and determine the resistance of the threads. After every discharge the stopper was turned a fraction of a revolution, and it was unmistakably demonstrated that the explosion produced not the slightest effect upon the position of the screw. The smallest catch or bite of the screw was sufficient to resist the shock of the discharge."

This semi-official statement, however, being at variance with well-known mechanical laws, as well as with the results of the experiments made elsewhere, must be taken *cum grano*. It may perhaps be excusable in the French authorities, after an accident like that on board the Montebello, to endeavor, by a pious fraud, to restore among their own men full confidence in their guns, but those who know anything of the difficulties of securing the breech of heavy cannon, will be chary in believing that the "smallest catch, or bite," of a screw already half cut away, was sufficient to resist the shock of a discharge of 55 pounds of powder, behind a shot of 320 pounds in weight. Though the authorities appeared satisfied that the manner of closing the breech was not defective or dangerous, the Montebello accident clearly showed that some precaution was indispensable to prevent a similar occurrence taking place, and that the possibility of so serious a contingency must not be left in the hands of the gunners. To obviate the danger resulting from a neglect to screw up the stopper, when it was in its place and the breech closed, the following arrangement was employed: The lanyard, or firing string, is caused to pass through the eye of a piece of iron fixed upon the breech, and carries a bob upon it. When the handle is not in its place, that is, when the stopper is not safely screwed in, a spring closes the eye and will not allow the bob to pass, and as the length of the string is so adjusted that in this position it cannot fire the gun, all danger is prevented. When, however, the handle is in its proper position, it acts upon the spring which opens the eye, and allows the bob to pass, and affords a sufficient length of string to fire the gun.

Our next woodcut represents the 9½-inch gun, and as the others are similar in their proportions, it will give an idea of the form and outline of each calibre.



French 9½-inch naval gun

The following table of details of their relative dimensions, from an official source, will supplement the sketch:

Gun.	Length.	Diameter at breech.	Weight.
6½ inch	11.54 feet	2.11 feet	11.200 lbs.
7½ inch	12.51 feet	2.57 feet	17.900 lbs.
9½ inch	14.95 feet	3.27 feet	30.800 lbs.
10¾ inch	15.32 feet	3.72 feet	48.160 lbs.

The 6½-inch gun is rifled with three parabolic grooves, their inclination varying throughout the length of the piece; near the breech it is zero, and it gradually increases towards the muzzle, where it acquires a maximum of six degrees. The 7½-inch and 9½-inch guns have the same twist as the 6½-inch, but with five grooves. With a charge of powder weighing 11 pounds, and an oblong cast-iron shot 70 pounds in weight, the range of the 6½-inch gun varies with the angle of elevation as follows:

With an angle of 2 degrees, the range is 1,040 yards; with that of 10 degrees, 3,850 yards; and with an angle of 35 degrees it reaches 8,000 yards. The lateral deviation of the projectile, at the last mentioned range, is 52 feet, and the average longitudinal deviation amounts to 144 feet. Besides the above results, others are obtained with a charge of 16 pounds of powder, and by the employment of a different projectile. With this second charge a solid steel shot is used, weighing almost exactly 100 pounds, and having either a cylindrical or ogival-cylindrical shape. The range of this projectile at an elevation of 4 degrees gives an average of 1,870 yards, or rather over a mile.

With a charge of 17½ pounds of powder and a cast-iron shot weighing 115 pounds, and with elevations of 2°, 10°, and 35°, the ranges of the 7½-inch gun are respectively 1,000 yards, 3,640 yards, and 7,700 yards. A maximum lateral deviation of 45 feet is produced by the last range, and the longitudinal deviation, taking the mean, equals 140 feet. Increasing the charge to about 28 pounds, and using a solid shot of the original shape weighing 165 pounds, produces no particular effect within a range of 1,000 yards from that already afforded by the elongated projectile.

A charge of thirty-six pounds of powder, and a cast-iron oblong shot weighing on the average 220 pounds, and with the same elevation as before, gave the separate ranges of the 9½-inch gun, as 1,100 yards, 4,000 yards, and 8,600 yards. The second charge consisted of forty-five pounds of powder, and a solid steel ogival-cylindrical projectile, weighing about 320 pounds. With an elevation of three degrees, the latter projectile carried 1,230 yards, and the former just 100 yards less. No accurate results of the firing of the 10¾-inch gun have yet been recorded.

The gun-carriage of the 9½-inch naval gun, as well as of the other calibres, is of wrought iron, and rests upon a frame also of that metal, and which is attached to the side of the vessel by a bolt; it rests upon small rollers, provided with studs, between which levers can be introduced for the purpose of slewing the gun laterally. Underneath the part of the

gun lying in the carriage are fixed cross-ties, furnished with strong springs for the purpose of diminishing the violence of the shock and the strain upon the cordage. The holding tackle passes round a pulley fixed upon the front part of the frame and is also connected to the cross-ties. These cross-ties are formed with a curve in their centre part to clear the lower portion of the breech of the gun. To elevate the muzzle of the piece there is a chain passing round a wheel inside each of the boxes forming the upright carriage. An endless chain, worked by a crank handle, sets this wheel in motion, and raises or lowers the gun at pleasure. In order to diminish and retard the recoil, each side of the carriage is provided with a brake clasping the corresponding side of the frame. The breadth of the sides of the frame upon which the brakes act is increased gradually as the piece recoils, and consequently the friction increases as the velocity of the recoil diminishes, so that the resistance to the force developed by the discharge upon the carriage is always approaching to a maximum, while the force itself on the contrary is in a continually decreasing ratio. Together, the carriage and frame weigh about six and a quarter tons, thus making the total weight of carriage and gun equal to twenty tons.

FRENCH 40-TONS SMOOTH BORE.

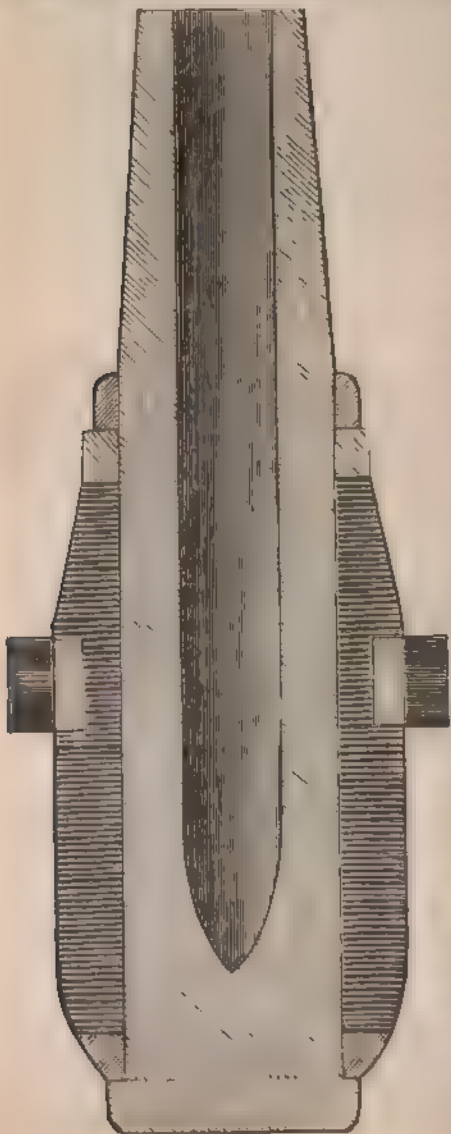
Close to, and towering above, the guns we have just been describing, is a smooth-bore cannon. This gun is constructed on the same principles as the others, with steel re-enforce rings, and the same breech-closing arrangement. It is 18 feet long, 16½-inch bore, and weighs about 85,000 pounds. It has a breech preponderance of 1,300 pounds. The diameter of the shot is 16 and three-eighth inches; it weighs about 650 pounds, and is fired with a charge of 110 pounds of powder. This gun, which is the first and only one of its size in France, has not yet been proved further than to fire a couple of rounds with ordinary charges.

The three most noticeable points about these French guns are, first, the care bestowed on the selection of the materials for their manufacture; second, the re-enforce breech-rings; and third, the breech-closing arrangement. In regard to the first, there can be little doubt that whatever may be the intrinsic value of the ores from which these guns are made as compared with those of our own and other countries, the French guns will possess a uniformity of texture and strength which cannot be expected from the productions of private firms. We have noticed the severe tests to which all the iron admitted to the arsenal at Ruelle is subjected. This and the subsequent treatment and mixture of the different ores argue the existence of authority and system rarely met with outside of military establishments. There is no lack of instances to prove that without a rigid government inspection the cannon of private firms will deteriorate according to the state of the market and other circumstances bearing on demand and the means of production. The Swedish cannon founders, at one time, had almost a monopoly of the cannon trade of Europe, and

the demands upon them were so great that the usual care in the selection of ores was relaxed; the guns fell off in quality and reliability, and consequently the trade almost left Sweden. This sharp lesson was not lost on the Swedes, for at Finspong, where the ordnance for the government is manufactured, the selection and treatment of the ores are as rigid and scientific as at Ruelle.

REINFORCE RINGS.

With reference to the second feature, though the metal of which the French naval guns are made be as good as the attainable ores and the present knowledge of their treatment can be expected to produce, it does not seem to satisfy the desires of the government, as the universal system of reinforcing clearly indicates. We have before referred to the reinforce of steel rings applied to the breech of these guns, a system which seems to prevail extensively throughout Europe, if we may judge from the number of rings supplied by a single firm before the commencement of the present year. In addition to those furnished to the French government, Messrs. Petin and Gaudet have supplied rings for 800 cannon to Italy, 500 to Spain, 130 to Russia, 180 to Denmark, 25 to Turkey, 40 to Sweden, and 120 to England. We are not aware, however, that any reliable series of experiments have been made to prove that these reinforce rings really do strengthen the guns to which they are applied. If, as Professor Barlow alleges, "the metal in any cylinder decreases in utility in proportion to the square of its distance from the centre, and therefore the outside of a gun of the form now used is only one ninth as useful as the inside," it follows that these steel rings add but little, if anything, to the strength of the guns. Indeed, it is doubtful if they rea-



Ericsson 13 inch gun.

compensate for the homogeneous metal cut away to make place for them. The strongest argument which the advocates of reinforcing use in their favor is, "that they prevent the gun from bursting explosively;" in other words, they "save the pieces." But if this be their only use, surely steel is neither the best nor the cheapest material; a soft wrought-iron reinforce would be preferable, and perhaps the system adopted in Ericsson's 13-inch gun would be the best. The barrel of this gun is strengthened by forcing over it washers of wrought-iron by hydraulic pressure. The core or solid part of the gun is thus put into compression while the washers are put into extension. The cone has longitudinal fibre only, being welded up from bars. Ericsson guarantees that this gun will stand 100 pound charges.

BREECH PLUG.

Without dwelling on a point which can only be satisfactorily settled by a long and expensive course of experiments, we come to the third and most distinctive feature of these French guns, namely, the breech-closing arrangement.

This, though an American invention, has not given such satisfaction with us as to lead to its adoption. Indeed, the idea of effectually closing the breech in this way has been long ago discarded in America. We have already referred to the blowing out of the breech of a gun on board the Montebello, and the experiments entered into in consequence, to test the reliability of the officially adopted system of breech-closing. But these experiments, like all the French naval and military tests, generally prove too much. We hear one day of some *trial* at Toulon that demonstrates how speedily the best protected iron-clad can be destroyed; and then it is some small cannon (a profound secret of course,) that can sweep away a whole battalion at a single discharge. In the present case, in order to show the impossibility of the breech-screw proving unfaithful, the official report says: "After every discharge the stopper was turned a *fraction* of a revolution, and it was unmistakably demonstrated that the explosion produced not the slightest effect upon the position of the screw;" and lest there should be any doubt as to the meaning of the word "fraction," it is added, "the *smallest catch* or *bite* of the screw was sufficient to resist the shock of the discharge." This is just the case with all these French experiments which are made public, a certain result is given but the particulars are kept back; how easy it would have been to have given, in centimetres, the exact size of the "smallest catch or bite." With the manufacturers of heavy guns, all the world over, this one point of getting the breech to stand is the great desideratum. To obtain sufficient strength for that point, in a huge war-engine from which a heavy body is projected instanter, at a great velocity, with a force of 4,000 or 5,000 foot-tons, has been a matter of anxious study to all mechanicians who have dealt with the question; but to the French artillerist it gives no trouble, "the smallest catch or bite" of his half cut away screw is quite sufficient.

Leaving these assurances of strength to those who may be pleased to accept them, we may observe that the life of the screw in the breech of this gun will determine the life of the gun itself. Should this cast-iron screw strip, which is not unlikely, it could only be replaced by boring out the breech for the insertion of a steel or iron screw to receive the breech plug, a proceeding which would considerably weaken the breech, by multiplying the parts composing it, and by reducing the sectional area of the gun itself at the point where the inserted screw-piece terminated. The one advantage of the French screw, or rather half-screw, plug, is that the sides of the breech are not cut away, as in the English and German breech-loaders, for the insertion of wedges, bolts, and vent-pieces. But it is doubtful if this one advantage will compensate for the obvious and inherent weakness and uncertainty of the French system.

Standing by the jealously-guarded enclosure in which the French guns are exhibited, one frequently observes the intelligent artilleryman or gunner in charge making slight mistakes in pushing home and adjusting the screw-plug. The smallest surplus force applied in this operation will make the plug recoil enough to bring the square-cut ends of the threads opposite, when the plug will not, of course, answer to the lever until an additional push has been given to it, and sometimes it is necessary to draw it out again and return it with a force more nicely adjusted. If, in action, apart from the effects of a moderate sea, the plug should receive from some less experienced hand a push strong enough to make it recoil the breadth of one thread, or if the shot and charge were not pushed sufficiently forward, the threads of plug and gun might correspond and the lever be pulled round, leaving the breach improperly closed, with consequences that may be easily conceived. Again, the opening of the breech of a gun of nine and a half-inch bore and fifteen feet long, especially after firing to windward, would be followed by a cloud of smoke that, for a time, would greatly retard reloading and sighting, and possibly lead to serious local accidents, which, in battle, have a greater tendency to demoralize the men than even the shot of the enemy.

Besides the above evils there is another disadvantage (common to all breech-loading cannon of large calibre) arising from the necessity of handling, at every round, two heavy masses of iron instead of one.

RODMAN GUN.

A comparison between the large French smooth-bore cannon and the Rodman gun recently tried in England shows the weight of the former to be 85,000 pounds and the latter 43,000 pounds, or only about one-half the weight of the French gun. Now, with due allowance for the 1½-inch difference in calibre (the French gun being 16½-inch bore) and the breech arrangement, the French gun is either too heavy or the American too light; supposing the former to be of the same calibre as the latter, and say we deduct 14,000 pounds for the extra weight required to carry the *breech* apparatus, &c., for the difference in calibre, and 8,000 pounds

then a French smooth-bore gun of 15-inch calibre would weigh 63,000 pounds, or 20,000 more than the Rodman 15-inch gun. Perhaps the medium—53,000 pounds—would be a proper weight for a gun of this calibre. With this weight of the superior iron which abounds in the United States, and perhaps a judicious admixture of some of the best Canadian ores, guns of large calibre could be produced which would stand much heavier charges than those used at present. In 1862, a pair of cast-iron railroad wheels were exhibited in London (made from Canadian bog-iron ore) which had run 125,000 miles on the Grand Trunk railroad, under the post-office car, and seemed to be nothing the worse for wear. A portion of this ore, which produces iron of great toughness, mixed with some of our best ores, all selected and treated with the care bestowed on the manufacture of French cannon, could not fail to produce guns of unequalled excellence. If, with a charge of 60 pounds of powder the 15-inch gun gives a velocity of 1,320 feet per second to a shot of 440 pounds weight, it would give a velocity of not less than 1,600 feet to the same shot, if the charge could be increased to 110 pounds, or one-fourth of the weight of the shot.[1]

RODMAN GUN AND 8-INCH WARRIOR TARGET.

Before abandoning the reflections raised by the large French smooth-bore, and resuming our review of the heavy ordnance scattered over the Camp de Mars, it may be well, briefly, to notice the recent trial of the Rodman gun at Shoeburyness, and its effect on the English press. *The Standard*, referring to the trial for range and accuracy, says: "Fifteen rounds altogether were fired, and sufficed to give a valuable character to the weapon. The practice on such occasions as the present is to train the gun upon some definite object, such as a target, in a nearly horizontal direction—in this case two degrees of elevation taken with a spirit-level quadrant—and then to fire with various charges of powder, noting the spots at which the shots first graze, and the time, in seconds, from the discharge in which they do so. The rest of the flight of the missiles in their ricochets is only incidentally noted. The object is not to hit the target, but to find out the distances certain charges will project shots of the same weight, and the amount of deflection those shots experience and the velocities they attain in their flight." After giving details of the fifteen rounds, the article concludes as follows: "The American Rodman has thrown its shot very true and a very long distance. It was a pretty sight to see the dark ball rebounding from the mirror-like sea, dashing up a round cloud of spray at each ricochet, until at last, in the far distance, out amongst the grey hazy ships, a faint continuous white mist streaked for many seconds the surface of the water, and the thud, thud of the rebounds of the shot died away in a pulsating noise like the distant puffing of a railway train."

[1] Since the above was written, this gun, at Shoeburyness, gave a velocity of 1,538 feet, and a range of 7,680 yards, at 32° elevation, with 100 pounds of powder.

The Times, on the other hand, speaks disparagingly of Am and says "they look big and threatening, and make a great their shot strikes the outside of a vessel;" and yet, in the comes the reluctant confession that, "though the 15-inch shot through the 8-inch plate and backing, it would have pene of our ships." The organ of the government, *The Standard* candor, and in a fairer spirit, referring to the trial for penet

"The American 15-inch Rodman was tried yesterday 8-inch target at Shoeburyness with so great effect, that it m have proved its capability of penetrating any of our iron The Hercules ought to keep these missiles out, but she is n We do not for one moment intend to indicate any superi American 15-inch gun over our own 9-inch, or even, in mo smaller 7-inch guns, whilst Major Palliser has recently demo way for converting our large stock of 68-pounders and ot cannon into really efficient rifled artillery. Nor would we at tend that the heavier missiles of the American guns would h penetrative powers at long ranges as our own lighter elonga liser projectiles thrown at higher velocities. But it is som essential to know that American 450-pounder smooth-bor certainly hull our iron-cased vessels at 100 yards, and that h English man-of-war could be lain broadside against an A carrying guns of this calibre. In future the ships must b angle to each other; and hence one would naturally deduc sion than an additional reason is thus given in favor of the ity of the turret-ships capable of properly training the heav but directly fore and aft. Nor must we omit to consider p tingencies in the application by an enemy of such powerful guns, the shot from which are remarkably accurate in their 15-inch gun now at Shoeburyness is warranted proved, it is a limited number of battering charges of 60 pounds. But doubt that the gun would fire many rounds of 70 pounds of very little risk. What the effect of 10 pounds more powd might have been is, probably, that the 60-pound charge, ha sufficient to crush in the thick armor plates, the extra 10 po der would have carried the projectile completely through the ing. Now, the American gun might certainly be fired at a pounds of powder, and there can be very little doubt tha mander of a ship armed with such guns felt a conviction, as that he could knock a 15-inch hole in the side of a 9 or 10 clad enemy, that he would run the risk of bursting a gun f of sinking his antagonist."

The foregoing remarks all refer to the first trial of the against the 8-inch Warrior target with 60 pounds charges. as suggested by the writer in the Standard, has since been f pounds charges, at the same target, with results that are

agined than described. We give, in the accompanying woodcut a etch of the 8-inch Warrior target on a scale of half-an-inch to the foot, th a 15-inch shot impinging on the outer plate. The shot swept clean rough the target, carrying before it nearly a ton weight of the armor te *a*, the 18-inch teak backing *b*, *c*, the skin *d*, and the double frames (12 inches apart) together with four sets of the massive timber frames *f*. The ground, far and wide in rear of target, was thickly strewn with gments of iron and splinters of timber. In short, no such destruction s ever effected at Shoeburyness by any single shot.[1]

The exception made by the writer in *The Standard* in favor of the rcules is evidently made under a mistaken notion of the thickness the armor plates of that ship. From statements made in Parliat, by Lord Clarence Paget, when Secretary of the Admiralty, and ecially from the fact that a target having a 9-inch plate, and called "Hercules Target," was tried at Shoeburyness, the British public ieve that the armor of the Hercules is nine inches thick throughout. e armor plates of this vessel, however (as will be seen when we come speak of iron-clad ships,) are, mainly six inches thick, the same as se of the Bellerophon. True, there is a narrow belt of armor nine hes in thickness; but it is almost entirely below the water-line, whilst plates which protect her battery and her hull generally, being only inches, would be easily penetrated by the 15-inch Rodman, at 70 yards, th 60 pounds of powder.

FRENCH RIFLING.

There is one feature, connected with the French rifling, that demands passing notice, before we take a final leave of this new and untried stem of naval ordnance. The increasing twist, of course, will not mit of a shot having a long bearing, and which fits nicely into the ooves. Hence, the French used studs at both ends of the shot. The nt studs only give the spin to the shot, while the back row, of smaller e, act merely as a bearing to keep the shot centered if possible. Now, ugh the two rows of studs fit comfortably enough into the grooves at breech end, where there is no twist, they produce a jamming action the muzzle, and the back or smaller studs are invariably shorn off on

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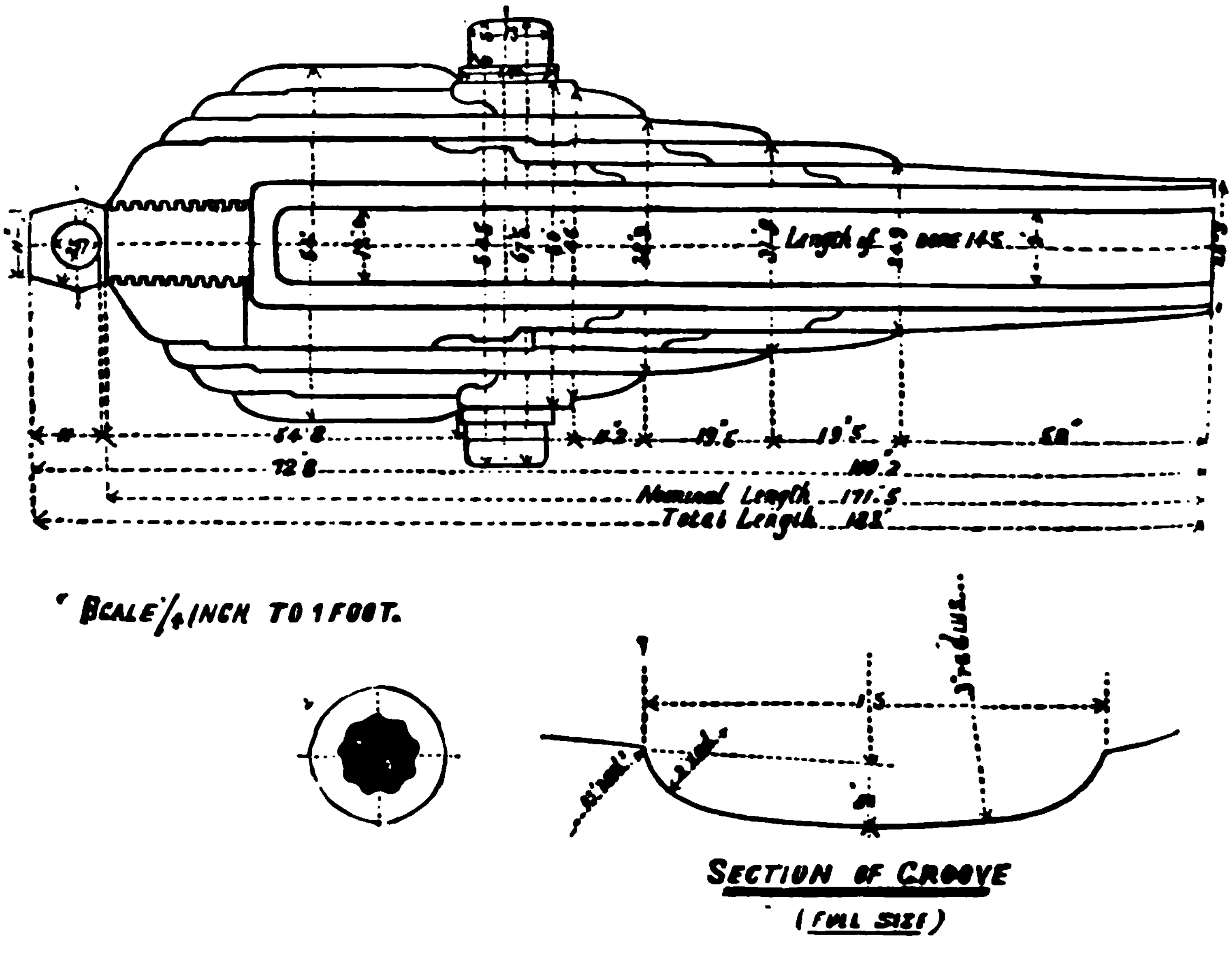
Before these trials took place, *The Engineer*, in speaking of American Ordnance, said: t is much to be wished that the real power of the heavy 15-inch and 20-inch guns was lerstood in this country, instead of our believing so generally in their 'low velocities.' the large chambers of these guns the powder gas has additional room for expansion, and, would be the case with steam cut off at a small portion of the length of a large steam inder, it thus does more work. In reality, while the dynamic value of our cannon pow-, for each pound weight, is but about 170,000 foot-pounds, that of no better powder, fired he large-bore American guns, is 200,000 foot-pounds. Thus, the fifteen-inch gun, fired h 60 pounds of powder and a 440-pound shot, has an initial velocity of 1,320 feet per sec-l, a rate which would certainly not be considered slow by our own ordnance engineers. r system of small bores and long shot not only strain our guns excessively, but loses us ch of the useful effect of our powder."

leaving the gun. At least, such is the case with several shot that have been fired, and which are shown in the Exhibition. This shearing action takes place just as the shot is leaving the gun, and the fillip it thus receives frequently gives it a wobbling motion, which cannot fail to be detrimental to its penetrating powers at close quarters and its accuracy at long ranges.

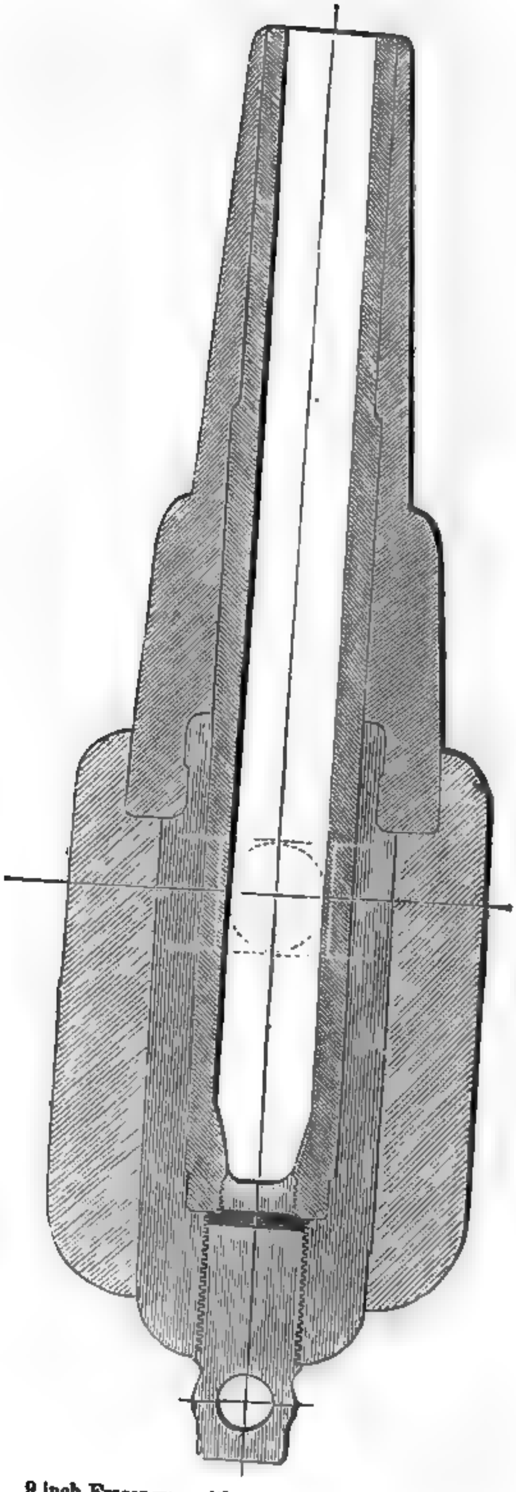
BRITISH HEAVY ORDNANCE.

Though the exhibit of the British secretary of state for war is certainly the most imposing, comprehensive and instructive of all the warlike displays on the Champ de Mars, it is not our intention to speak of it as a whole, but rather to select, under the several heads of our report, those features which properly belong to the question under review, and which serve best to illustrate the progress made in the several branches to which they belong. In "heavy ordnance," there is no collection that can compare in completeness with the British. The Prussians and French both show heavier guns, but in uniformity of system, and detail, the display of Woolwich arsenal stands unrivalled. At the head of this display of wrought-iron cannon is a 12-inch muzzle-loading rifle, said in the official catalogue to be made on what is now termed the "Woolwich principle;" in other words, the Armstrong system with certain modifications and improvements introduced by Mr. Fraser, the manager of the



Armstrong (Woolwich) 23-ton, 12-inch gun.

gun factory; but the gun is an Armstrong *pur et simple*, as the annexed woodcut, copied from the official catalogue, clearly shows. A comparison between this engraving and the two next in order, will illustrate the *steps* by which Mr. Fraser is endeavoring to reach homogeneity in the



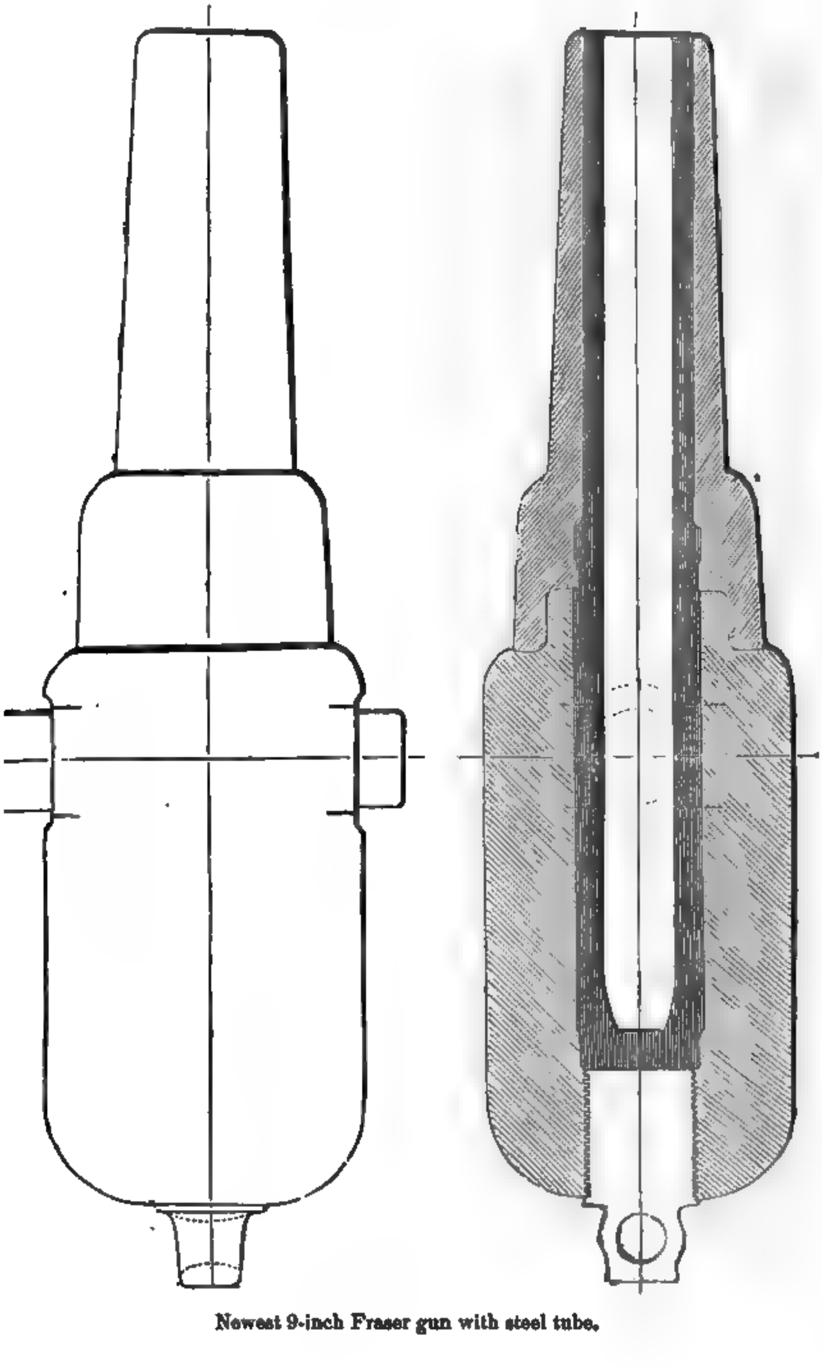
9 inch Fraser gun with wrought-iron tube.

material of the Woolwich guns. Both are built upon the coil system, and the barrels, when polished, have the appearance of the twisted barrels of small-arms. The iron used for the several coils, by the different makers, is of the same size, and that used at the Royal arsenal is a low-priced fibrous iron ranging in price from £7 to £10 per ton. Armstrong makes a spiral coil of this iron, welds it into a cylindrical form, and then turns and finishes each cylinder or part separately, before putting the pieces together. Fraser also makes a spiral coil, but instead of welding or finishing each coil separately, he coils say three spirals in the rough bar on a mandril, or shaft, and then welds the whole together. The foregoing woodcut, on a half-inch scale, illustrates one of the latest patterns of Fraser guns made as described.[1]

That these guns possess greater strength or endurance than the coil guns consisting of many parts is generally admitted, though none of them have lived long enough as yet to place the endurance of wrought-iron guns beyond a doubt. After a time these coil guns disappear, one by one, from the experimental grounds at Shoeburyness, and find their way to the ordnance hospital at Woolwich. They seem, as it were, to have some chronic disorder, requiring constant care and skilful treatment. In the larger calibres especially, a gun that has fired 500 rounds is quite a prodigy of endurance. There is, however, a tradition of one nine-inch gun having fired 1,000 rounds. After 500 rounds, the soft iron tube was found to be so much scored and worn by the gas, that it was sent back to Woolwich, where the vent was plugged up, the gun reversed, and a new vent bored in the opposite side, when it is said to have fired 500 rounds more. The theory of the gradual destruction of these large coiled wrought-iron guns seems to be as follows: The heavy discharge of powder heats and expands the inner tube to a great degree before the outer rings, which have no homogeneous connection with the inner, are sufficiently heated to expand and give the inner tube room; consequently the particles of the contiguous surfaces of these tubes are so compressed, that when the firing has ceased and the temperature of the gun returns to its normal state, the outer cylinders or rings, having had their particles compressed, do not shrink sufficiently to bear upon the inner tube, which at subsequent firings has to sustain the entire force of the explo-

[1] The peculiar feature of this gun is the conical shape of the chamber alluded to in the following extract from *The London Standard*: "With the exception of slight scoring, the inner tube of the service construction gun is perfectly sound; that of the Fraser gun shows a small hole in the rear end near the axis, rather more than an inch deep, attributed to the concentration or focussing of the gas, owing to the peculiar conical form of the chamber. This form was adopted to lessen the area of the end of the tube directly opposed to the longitudinal strain, and to distribute that strain over a larger total surface; and it is supposed that a modification of the form of the chamber will prevent the possibility of such a fault in other guns; but it is doubtful if the defect is of much importance as it now stands, and it is unlikely that it would have arisen had not the gun been fired not only with heavy charges, but with considerable rapidity, (from 25 to 50 rounds a day,) so as to generate enormous heat, and actually burn the metal at this point."

on, until it heats and expands so as to get the support of the coils urrounding it. The seam between these coils widens as time wears on, nd it is not uncommon to see a gun, that has only been fired 40 or 50



Newest 9-inch Fraser gun with steel tube.

times, in such a state that the blade of a penknife might be inserted between the coils. The Fraser system, by producing a greater degree of homogeneity, has, to some extent, overcome this defect, but whether it is entirely eradicated or not, is a question which time only can decide.[1] The 12-inch gun exhibited weighs 52,640 pounds. Its length of bore is 12 feet 1 inch, and over all it is 14 feet 3½ inches. It is rifled with nine grooves, with a spiral increasing from one turn in 1,200 inches, to one turn in 600 inches, or 50 calibres. The elongated projectile used in these guns weighs 600 pounds, and the charge of powder is 70 pounds, which gives an initial velocity of 1,200 feet per second. This gun is mounted on a wrought-iron casemate carriage and platform, fitted with Armstrong's self-acting compressor, (9 plates, nine feet 10 inches long.) The carriage weighs 5,712 pounds and the platform 12,470 pounds, which, with the gun, makes a total weight of 70,822 equipped for land service. Several guns of this calibre are also designed for naval service, and the "Captain," a turret-ship building for the government by Laird Brothers, of Birkenhead, is to have a couple of these 12-inch guns in each of her two turrets. The British guns, however, chiefly designed for naval service, are the 10-inch 18-ton gun, the 9-inch 12-ton gun, and the 7-inch 6½ ton gun. The 10-inch gun is not in the Paris Exhibition, but the others are exhibited mounted, and equipped for sea service. The 9-inch gun, of which the woodcut on page 107 is the latest pattern, weighs 27,014 pounds; the bore is 10 feet 5 inches long, and the length over all is 12 feet 5 inches. It has six grooves, and a spiral of one turn in 45 calibres. The projectile weighs 250 pounds; the battering charge is 43 pounds, and the service charge 30 pounds, with the respective initial velocities of 1,370 feet and 1,230 feet per second. The gun is mounted on a wrought-iron naval carriage and slide, fitted with Armstrong's compressor, and Scott's running-in-and-out gear. It admits of a maximum elevation of 14 degrees, and a depression of eight degrees. Neither this nor the 12-inch gun has any breech preponderance. The 7-inch gun, however, has a breech preponderance of 560 pounds, and weighs altogether 14,504 pounds. It has three grooves, a quicker twist—one in 35 calibres—and is mounted similarly to the 9-inch gun. The weight of the

[1] "One 9-inch gun has now fired 1,043 rounds, of which the last 500 have been with battering charges of 43 pounds of powder, and shot of 250 pounds weight; while of the preceding 543 rounds 180 were with battering charges varying from 40 to 50 pounds. The upper surface of the bore having suffered considerably from erosion, or scoring, caused by the rush of gas over the projectile during the first 543 rounds, the gun was vented through the original under side, which then became the upper side; and the last 500 rounds were fired after this change had been made, the original vent being of course plugged up. To prevent this scoring papier-maché wads between the cartridge and projectile have been introduced with beneficial results. The importance of this result cannot be overestimated, for the scoring consequent upon the windage was the greatest enemy of the steel tube of a muzzle-loader, causing it to split to such an extent that the limits of safety for the 9-inch guns were defined as 400 rounds, only 150 of which might be battering charges."—*Standard.*

projectile for the 7-inch gun is 115 pounds, the service charge is 14 pounds, and the battering charge 22 pounds; giving, respectively, initial velocities of 1,240 feet and 1,440 feet per second. A 7-inch breech-loading polygrooved rifled gun on the Armstrong vent-piece system is also exhibited, mounted on a wooden casemate sliding carriage, and wooden traversing platform. This gun is completely equipped for land-service, and its rifling and breech-closing arrangements are similar to those of the 12-pounder field gun. A 40-pounder breech-loader mounted on a travelling siege carriage, weighing 7,300 pounds, is also exhibited. Had this Exhibition taken place two years ago, perhaps the most interesting gun in the collection would have been a 64-pounder wrought-iron, muzze-loading, *shunt* gun, which now attracts but little attention. The shunt rifling was evidently devised for the better centring of the shot, and perhaps to neutralize the scoring effect produced by the escape of gas over the projectiles, or by the friction of heavy shot on the lower side of the bore of the gun. This is effected by making one half of the groove deep, and the other half shallow. In loading, the shot slides down the deep groove, and at a certain point in the bore of the gun, in coming out, it shunts off to the shallower portion of the groove, thus raising the shot clear of the inner surface of the gun, and placing it fairly in the centre of the bore as it passes out. This plan of rifling, however, has now been superseded by the increasing twist system of the French ordnance; because the latter seems to give the best results in regard to penetration. To this one quality all other requisites of ordnance, such as range and accuracy, are being sacrificed by the British authorities.

The British government collection comprises in all ten pieces of ordnance, besides the guns exhibited by Whitworth, Armstrong, and other private makers. Some of these guns have been mentioned in connection with "Field Ordnance," and others are too well known to require special mention; but before taking leave of these wrought-iron guns, especially the naval guns, a few words require to be said on the system of rifling, and its effects on the utility of the gun as an engine of war.

Visitants at Shoeburyness, before the cheap construction or Fraser guns were made, and before French rifling and Palliser shot formed part and parcel of the British system of ordnance, were generally astonished at the unerring accuracy of the firing.[1] The white paint bull's-eye, about the size of the shot to be fired, was generally struck fair in the centre at 200 yards' range, leaving often an annular ring of paint around the hole or indentation made by the shot. The improvements referred to having,

[1] At the target trials in 1862–3, the accuracy of the firing often attracted the special attention of the representatives of the press, one of whom says: "The general precision of the firing for the day was remarkable, and in some instances, and those in quick succession, the practice was quite astonishing. The bull's-eye was marked each time with a brush and white paint, and the circular patch never exceeded nine inches in diameter. Frequently the shot was made to strike in the very centre of this spot, leaving an annulus or ring around the point of impact."

as stated, only penetration in view, have changed all that, and now that the testing range is reduced to 70 yards, the firing is greatly inferior in accuracy to what it formerly was at 200 yards. The following is a table of the radial deviation of a dozen rounds of the Woolwich guns, with Palliser shot, fired in September last, (1866,) at 200 yards' range. The deviation is protracted to 800 yards. The target was 40 by 9 feet, with 20 feet inclined away 30 degrees, making visual length from guns 32 feet:

Nature of gun.	Number of round.	Deviation as measured at 200 yards.	Deviation as protracted to 800 yards.
Twelve ton 9-inch	7th	Bad; miss	
Do	8th	Bad; all but miss	
Do	9th	2 feet 6 inches	10 feet 0 inches.
Do	10th	1 foot 2 inches	4 feet 8 inches.
Do	11th	1 foot 6 inches	6 feet 0 inches.
Do	12th	1 foot 2 inches	4 feet 8 inches.
Do	13th	1 foot 11 inches	7 feet 8 inches.
Do	14th	1 foot 4 inches	5 feet 4 inches.
Do	15th	2 feet 2 inches	8 feet 8 inches.
Do	16th	4 feet 7 inches	18 feet 4 inches.
Do	17th	1 foot 7 inches	6 feet 4 inches.
Nine ton 8-inch	24th	2 feet 8 inches	10 feet 8 inches.
Do	25th	1 foot 0 inches	4 feet 0 inches.
Six and a half ton 7-inch		2 feet 0 inches	8 feet 0 inches.

It should be borne in mind that this firing was from a fixed battery, at a fixed target, and that the guns were laid by the late Lieutenant Reeves, of the Royal Artillery, who was perhaps one of the best marksmen in England, if not in Europe. We may remark, *en passant*, that it seems very strange that these shot, notwithstanding their greater velocity, have often less penetrating power at 70 yards than at 200 yards. This may be due in some measure to the wobbling motion supposed to be given to the shot by the peculiar rifling, and the stud arrangement, which imparts the spin to the shot. It is supposed that the shot loses this eccentric motion as it travels onward, just as a top acquires a steadier spin a second or two after being freed from the string that sets it in motion. Hence it is believed that at 200 yards the Palliser shot has lost the swaying flight given it by the fillip which the rear studs receive on leaving the gun. (The British, unlike the French, make the rear studs take the grooves and guide the shot.) As in the case of the top the swaying motion revives as the power in the projectile diminishes, these shot, from the insufficient twist given to the rifling, would probably turn over at comparatively short ranges. There has been no comparative trial, such as the Armstrong and Whitworth, yet made of the range and accuracy of these Woolwich guns and Palliser shot. When to the above record of indifferent firing we add the facts that these naval guns are to be mounted on such unsteady platforms as the English iron-clads, which are notoriously *crank* ships; that they are destined to fire at movable objects, and that the ricochet of rifled guns generally goes for nothing, their *chances* of hitting an enemy's ship in a naval action are very remote.

That they can in no case be certain of hitting the spot aimed at, even under the most favorable circumstances, has been clearly proved. Therefore, instead of using the superior speed claimed for British iron-clads, so as to choose their position or distance in action, these ships will be compelled to come to close quarters, or retire altogether. The former alternative, against vessels of the Monitor type armed with big smooth bores, would, to partially protected ships of the Warrior or Bellerophon class, be certain destruction, or indeed (as the late experiments at Shoeburyness prove) to any British iron-clad afloat. These matters will be more fully noticed under the head of iron-clad ships, but it is impossible not to be impressed with the unwisdom—the strange fatuity—which is compelling the British and French governments to trust to rifled guns alone for their naval armaments; thus, as it were, putting all their eggs into one basket. True, one British ship, the "Royal Sovereign," is armed with 10-inch smooth-bores; but for this superior armament she is indebted less to a friendly feeling on the part of the authorities than to the belief that by refusing to give her rifled guns they were evincing their disapproval of the vessel as a sea-going ship, and of the turret principle on which she is constructed.

RELATIVE VALUE OF SMOOTH-BORE AND RIFLED GUNS.

Two years ago these nations had, in the Kearsarge and Alabama engagement,[1] an eminently practical lesson of the relative value of smooth-bore and rifled guns. But all sorts of excuses were invented to favor the vanquished, the practical lesson was thrown away, and those derived from firing at 70 yards' ranges at Shoeburyness, and 20 metre ranges at Vincennes, were taken in preference. The true sailor, as if by instinct, takes to smooth-bore guns and round shot, as more congenial to the

[1] Since the above was written the following paragraph appeared in the columns of *The London Standard* one of the organs of the present government in England. It shows that since the trial of the Rodman gun at Shoeburyness, American gunnery is beginning to be better understood and appreciated:

"During the wars of 1793–1815 our ships were for the most part armed with two different sorts of guns, the long gun and the carronade; the first, of moderate bore, being for range, and the latter, with large bore and short length, for close quarters. Now our rifled guns possess great range, great accuracy, and great penetration, but small diameter; while the American guns possess great shattering power, the advantage of ricochet when required, and are made at a moderate expense. Would it not be a wise step to arm our ships with some of each sort? If an enemy's side was penetrated by the rifled shot and then struck near a wounded part by a 450-pound ball, an awful rent might be made, while rifled bolts would only continue to cut small, clean holes. At all events, against wooden ships and slightly plated ships, within moderate range, there can be little dispute that large globular balls would be most destructive, as proved in the conflict of the Alabama and Kearsarge. The Alabama was armed with rifled and long guns, and the Kearsarge with the wide-mouthed Dahlgren guns, which succeeded in tearing such large apertures in her opponent's sides that the latter was soon sunk. There is reason to believe that the chief aim of American gunnery will be not so much to batter an enemy's hull as to sink him by blows between wind and water. Their turret ships are peculiarly favorable to such a system, for the guns are very near the water-level, and the immense round shots are admirable for low ricochet firing."

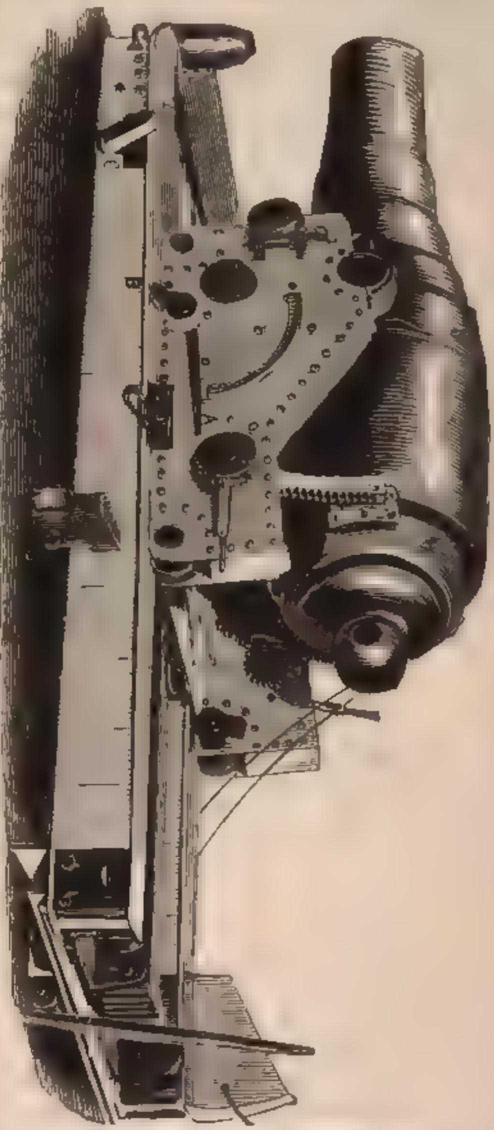
element on which he lives and fights, than rifled cannon and studded projectiles. So the common sense of experienced naval officers is a safer guide in matters connected with naval gunnery than the opinions of boards and ministers, who are fettered by red tape and routine, and often bamboozled by ordnance manufacturers and interminable official reports. During Admiral Farragut's visit to England, the practical seamen at Portsmouth wished him to see some gun practice, but though hundreds of rifled cannons were ready when the order, "beat to quarters," was given, "they went," says the newspaper report, "to the guns and handled the great 100-pounder smooth-bore Armstrongs with surprising ease and alacrity. The order was given, 'load with shot,' and in a few seconds the big guns were shotted, pointed, and ready for the order to fire. The American officers went to the quarter-deck of the ship to witness the practice. On the word 'fire' being passed, the shot was seen to throw up a jet of water in direct line with the target, passing under the canvas itself between the uprights. Several shots were fired at the target 1,800 yards distant, and the practice was remarkably good. The third shot ricochetted, going through the centre part of the target." No such result, save by accident, would follow the ricochet of a rifled shot.

We have no desire to decry improvements, or to undervalue heavy rifle guns; they have their sphere of action, which is more properly the casemate of a land fort than the cupola or broadside of a ship of war. One or two such guns might be judiciously used on board ship as chasers in fine weather. But in a moderate sea, and at medium ranges, the large smooth-bore will lay its shot on the water, which with almost unerring certainty will guide it to the object, whilst the erratic ricochet of the rifled projectile can never be depended on.

ARMSTRONG 12-TON GUN.

After the description given of the Woolwich guns, which, with the exception of the improvements introduced by Mr. Fraser, are the same in principle as the Armstrong guns, it will not be necessary to give any extended description of the latter. The largest gun shown by Sir William Armstrong & Co. is a 9-inch wrought iron muzzle-loading rifled gun, weighing twelve and a half tons, (English.) The gun is mounted on a carriage and slide, which together weigh four and a half tons. The compressor for checking recoil (a modification of the American) is wholly of iron. A series of plates, eight or nine inches wide, one inch thick, and placed about an inch apart, are secured to the slide at the end. Between and embracing these plates, or bars, are similar ones attached to the carriage, and against this series of plates on one side of the carriage comes a regulating or set screw, which, accordingly as it is screwed up, regulates the recoil by jamming the plates together. The full compression is put on by moving the handle A, in the wood cut, to its present position. Should this operation be neglected, the clutch B coming in contact with the stud C, when the gun recoils, makes the com-

act of itself. This compressor also serves to control the gun when in or out in a seaway. The gun and carriage exhibited have been at sea. A similar d to the French gov-t, has been experi- with at Vincennes the present season, t is the secresy main- t these French trials one connected with wick Works, where was made, was per to be present at the Whether from indif nnery, bad powder, other cause, the gun do so much execu Vincennes as sim as from the same have done at Shoe-s. This may be due measure to a cir nce already noticed, , the proximity of to the target. At ryness the experi- range, till lately, was rds, while at Vin- it is only 20 metres, yards. If, then, the les of these rifled e less effective at 25 yards than at 200 t follows that it will he interest of ships with smooth bores to close quarters. The shot, never having aying or wobbling



Armstrong 9-inch gun and carriage.

has its maximum penetrating power at the muzzle of the gun. One teel shot fired from this Armstrong gun at Vincennes, at 25 yards direct at the target, actually struck it with its side, and stuck in the plate, almost parallel with the front of the target. This, and unds fired the same day, seem to prove that these shot at short have not acquired the direct flight which they obtain after travel- or 300 yards.

WHITWORTH GUNS.

Near the display of the Elswick gun-factory are the guns of strong's great rival, Mr. Whitworth.

The heavy guns exhibited by the Whitworth Company are a 32-po (Fig. 1,) a 70-pounder, (Fig. 2,) and a 150-pounder, (Fig. 3,) which, w several specimens of shot and shell, are illustrated.

"The leading features of Mr. Whitworth's system," says *Engi* "are the hexagonal bore, the sharp twist of the rifling, and th proportional length of the projectiles; and these three features b dependent on each other. Without rifling of sharp twist, it w impossible to give the long projectiles that rapid spin which is ess necessary to keep them steady, and this sharp twist in its turn tates the adoption of such a form of rifling as can impart the r spin without incurring the risk of stripping the projections on t jectiles. We have called the bore of Mr. Whitworth's guns hex but this is scarcely a correct term. The sectional form of his pr is a hexagon with the corners cut off, the lines cutting off the being arcs of circles struck from the centre of the hexagon. If t of the gun was made of precisely the same shape as the shot, th would be that the shot, being slightly smaller than the bore, woul being driven out, bear upon the bore at each corner only. To av and give the shot greater bearing surface, Mr. Whitworth gives t of his guns a kind of twenty-four-sided form, each bore being fo twelve straight lines and twelve arcs of circles, disposed as To a casual observer the bore of the Whitworth gun appears t hexagon, with the corners cut off by arcs of circles, as in the case shot; but really each side of the hexagon is divided into two p a kind of shallow groove cut down its centre, this groove being of a circle struck from the centre of the bore. The two parts of t of the apparent hexagon, which are on each side of the groove, in a straight line with each other; but each inclines slightly ou from the centre of the bore, that edge of each side which is ne shallow groove being the nearest to that centre. The effect arrangement is, that when the projectile twists in the bore of the the extent allowed by the windage, the six sides of the shot are b into free contact for nearly half their width with six "half-sides," may term them, of the bore, and the amount of bearing surface shot on the bore thus given is very considerable. [The diagra page 115 will illustrate this explanation.] Whilst speaking of this ing of the shot in the bore of the gun, we should mention the has of equally distributing the windage all round the projectile. ordinary rifled gun a shot lays on the bottom of the bore whilst fired, and the greatest windage therefore takes place on the upper but in Mr. Whitworth's guns the case is different, the projectile *it starts* becoming accurately centred, and the windage being thus

d on all sides. This is an important matter, as it not only equalizes wear of the bore from the blowing through of the powder gases and

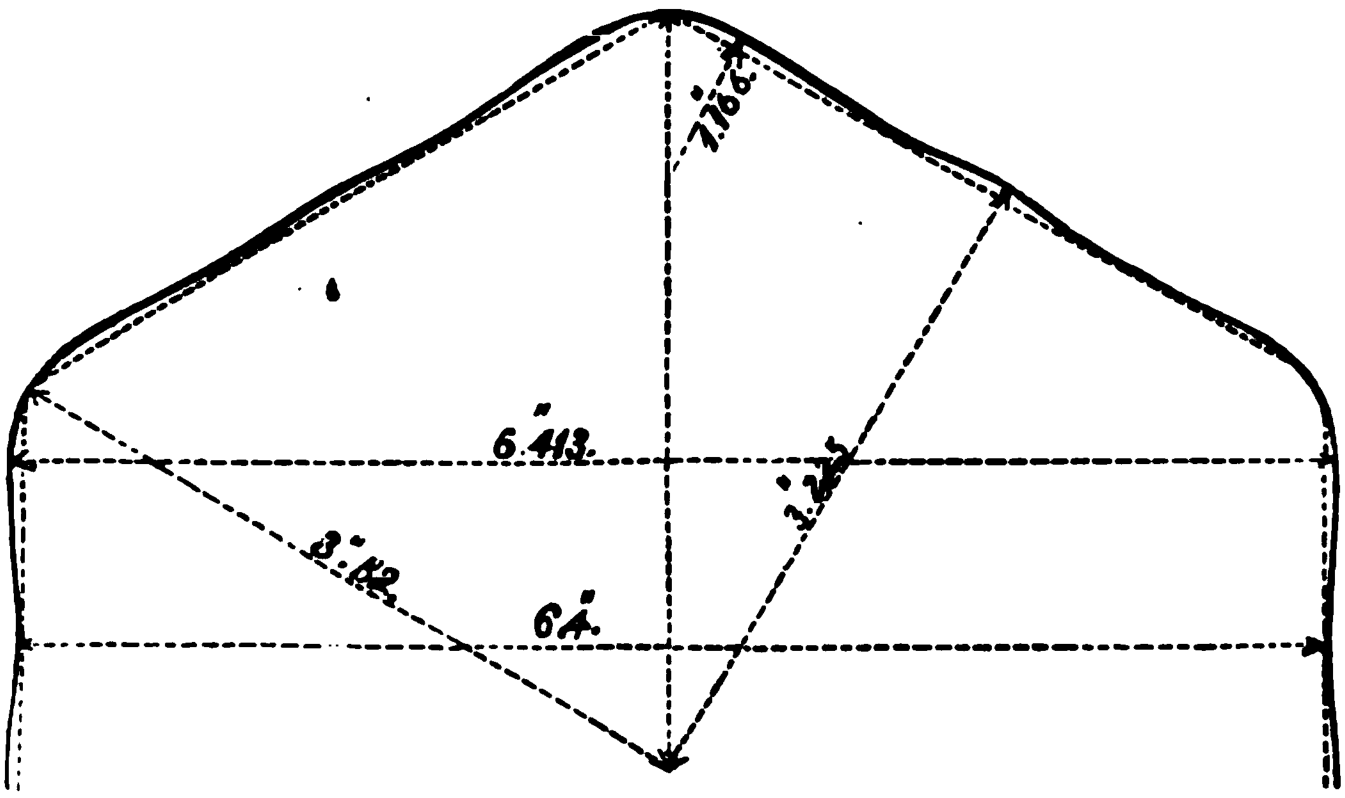


Diagram of Whitworth rifling.

grains of unconsumed powder carried by them, but also tends to 'ove the accuracy of the flight of the projectile."

range and accuracy the Whitworth guns have few, if any, equals. he Armstrong and Whitworth trials, the mean range of eighteen ds of the 70-pounder, at 21 degrees elevation, was 7,965 yards, whilst of the muzzle-loading Armstrong of the same calibre was 6,330 s, and the range of the breech-loader was only 5,821 yards. Thus Vhitworth was 37 per cent. superior to the breech-loading Armstrong, 26 superior to the muzzle-loader. In regard to accuracy, the com-e say that, "at ranges greater than 3,500 yards, the Whitworth gun bits a decided superiority over the muzzle-loading Armstrong, and atter a very marked superiority over the breech-loading Armstrong." further appears," they say, "from the table of ranges, combined with spection of the probable rectangles, that the Whitworth gun made practice up to a range of 8,000 yards; which is about 2,000 yards cess of the range attained by either of the Armstrong guns, at the elevation of 21 degrees." Throughout the whole of these trials superiority of both the Whitworth gun and the Armstrong muzzle-er over the breech-loader was very marked. Indeed these experiments to have finally settled the breech-loading question in England, at , so far as regards field and heavy ordnance.

ing beside the Armstrong and Whitworth guns is a cannon of about ns in weight, and 9-inch bore, manufactured at the Elswick Ord-e Works, and exhibited by Major Palliser.[1] It consists of a coiled

[1] This gun is constructed on the plan advocated by Major Palliser, a plan which, in a e recently delivered by him at the United Service Institution, he confidently predicted hortly become universal. The gun consists of an inner barrel of coiled wrought iron, d which, when placed in a mould, a casing of cast iron was run in the molten state. It ood some very heavy charges, having fired 18 or 20 rounds with 43 pounds of powder, th 45 pounds, and 4 with 55 pounds of powder, and with 250 pounds shot. The inner

wrought-iron tube of about two inches in thickness, over which is cast an ordinary cast-iron cannon. Several guns manufactured in this crude and unscientific fashion have been tested at Woolwich, and failed to meet the requirements of the government. A system of strengthening old cast-iron cannon, by lining them with soft iron tubes, has also been extensively experimented on at Woolwich by Major Palliser, but none of these guns are shown in the Exhibition. This system was first submitted to the authorities in England by Mr. Parsons, an American, who proposed to use a steel tube; but while the similar and subsequent proposals of Major Palliser receive every attention, those of Mr. Parsons are ignored, and, consequently, the experiments in connection with the lining of cast-iron guns are chiefly directed by the former. Few of these guns, however, have as yet been properly tested. The test to which they are subjected consists of a few rounds with increasing charges, which in nowise equals in severity that to which the French subject all the metal brought to their arsenal at Ruelle. Whether steel or wrought iron be the best lining for cast-iron guns, is at present a much debated question in Europe, especially in England. Foremost amongst those who side with the iron tube is Sir William Armstrong, but when he had to match his own gun against the steel-lined guns of Mr. Whitworth, he abandoned his favorite metal for that of his rival. The British authorities are now making all the Woolwich guns with steel tubes bored out of the solid bar, which argues that they consider the steel tube to be the best. This fact may perhaps influence the conversion of cast-iron smooth-bores into rifled guns, though nothing but a fair and thorough trial will set the matter at rest. The following extract from a letter of Mr. Parsons, to *The London Standard*, shows that he does not fear the result of such a trial.

"Let two 68-pounders," says Mr. Parsons, "be converted, the one on Major Palliser's plan, the other on mine, each of us having his gun altered according to his own design and under his own superintendence, and

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tube is full of faults, the coils having become separated by the action of the gas, and it seems probable that a few more rounds would have destroyed the gun. This inner tube was made with special care, under the immediate superintendence of Mr. George Rendel of the Elswick firm, and Major Palliser acknowledges the care and skill with which he carried out the operation. At the same time, however, it is stated that this inner barrel is very defective, and that some of the coils are imperfectly welded, whence their separation was comparatively easy. If this be so, it is a strong argument against the possibility of making wrought-iron tubes of the larger size with certainty, and tells in favor of those who advocate the steel inner barrels. Major Palliser, however, insists that it matters but little of what the outside of the gun be composed, so long as the interior, or heart, is coiled of wrought iron. Whether the system be adopted or not for the new guns, there seems little doubt that the principle will be extensively applied to the conversion of the smaller cast-iron guns of the service into rifled ordnance. The principle of that conversion depends upon the same supposition as the construction of the new guns, that the life of the piece is in the inner tube. There can be little, or, indeed, no doubt as to the feasibility of making perfectly sound wrought-iron coiled tubes up to six inches in calibre; but when we come to enormous charges the smallest defect of welding will be sufficient to give the subtle gas power to separate the coils; and that very defect is most *likely to* be present in the larger than in the smaller tubes."—*Standard.*

with all the latest improvements, the distinction between the two to be, that Major Palliser's is to have a wrought-iron coiled tube introduced through the muzzle, while mine is to have a reinforced steel tube introduced through the breech end, both guns to be of the same calibre of eight inches and to be rifled exactly alike, and to be tested to destruction by continuous firing with charges of 30 pounds of powder and 150 pounds of shot, and the one whose gun fails first, to bear the expense of altering both."

The fact that Major Palliser has not accepted this challenge, seems to imply that, like Armstrong in the hour of trial, he has less faith in his own views than in those of his rival.

KRUPP'S STEEL GUNS.

The large steel guns manufactured by M. Krupp, of Essen, have not yet taken so decided a position among heavy ordnance as his lighter guns have among field-pieces. The larger calibres have not only burst more frequently, but the accidents have sometimes been attended by fatal consequences, and the loss, as a matter of course, has been more marked than in the case of smaller guns. It is not, however, so much our object to collect lists of past failures, as to take notice of the present state of ordnance as exhibited in the Exhibition. Here, at least, M. Krupp has demonstrated the practicability of making larger steel guns than any that have yet been made from cast or wrought iron. His great gun, if it has not the calibre of our 20-inch Rodman, is much heavier, and throws a heavier shot. The gun itself weighs fifty English tons, or 112,000 pounds, and with its carriage and turntable it will weigh ninety tons. This gun, of which we give an illustration, is a rifled breech-loader. It is intended for the defence of some important harbor or naval seaport, and would certainly prove a source of great danger to any iron-clad that might come within its range. The diameter of the bore is fourteen inches, and the weight of the solid steel shot is 1,212 pounds. The shell weighs 1,080 pounds, and carries a bursting charge of only seventeen pounds of powder. These projectiles are to be fired with charges varying from 110 to 130 pounds. The total length of the gun is seventeen feet and a half. It may appear strange that so large a shell should carry so small a bursting charge, but the deep grooves required to hold the lead jacket cut away so much of the shell that there is no room left for a heavier charge. The projectile is made up of the cast-iron shell, 843 pounds, lead jacket 220 pounds, bursting charge 17 pounds, total 1,080 pounds.

The breech-closing apparatus is M. Krupp's invention, and is similar in principle to that in use in his field-guns, with the exception that the shot and charge are not introduced through the extreme end, but through the side of the breech. The inner tube of this gun is its most important feature, and when finished weighs twenty tons. It was forged under the fifty-ton hammer from a massive ingot of forty and a quarter tons; thus the waste in turning, boring, &c., has been over fifty per cent. The cast-steel rings are threefold at the powder chamber, and twofold nearer the

muzzle; these rings weigh altogether thirty tons, and have been factured in a manner similar to the tires for railroad wheels, from masses and without welding.[1]

The gun has not yet been proved or even fired, so its success problematical. Its weakest point is clearly its breech-closing ment, or rather the great slot cut through the central tube to rec shot and charge, and the closing breech-piece. True, the strain point will be wholly a tensile strain, but the vibratory action to the central tube will be subjected, immediately behind the en reinforce rings, may prove the ruin of the gun.

This cannon was in progress of manufacture for sixteen mont and night, without interruption. A special railroad wagon had constructed to bring it to the Exhibition, the railway companies none strong enough to carry it. This wagon constructed by M. has twelve wheels, and is manufactured entirely of steel and iron exhibitor of this monster cannon says, "the necessary mechani working the gun is such that two men can quickly and easily e depress, and turn the gun, and can, with the greatest speed and cer follow and cover any passing armor-plated vessel." Nothing is the facilities for loading, which is fully as essential as the traini elevating of the gun. The cost of the gun with carriage and tu is over $100,000. M. Krupp has presented it to the King of P The largest gun, made from one piece of steel, exhibited by M. Kr a 9-inch breech-loader, weighing twelve and a quarter tons. Thi with the exception of the trunnion ring, forged as described w welding, was made from one ingot, and forged under a 50-to mer. It has been fired 120 times with full charges—45 pounds o der. The total length of the gun is 180 inches, the usual charge 40 to 45 pounds, the weight of the solid shot being 330 poun that of the shell 275 pounds. The polygrooved rifling and lead shot of M. Krupp can only be used with advantage in breech-l guns, hence, whilst other makers are abandoning breech-loadi muzzle-loading cannon, M. Krupp is taking quite the opposite and seems to have come to the conclusion that all large guns ough breech-loaders. In this, as already observed, he is seconded by th lerists of Ruelle. The heavy coating of soft lead, which surround steel shot, will demand great care in storing and transportation, the deep grooves cut in the steel to retain the lead reduce the st of the shell to such an extent that it can only contain a very insigni bursting charge; the Armstrong and Whitworth 9-inch shells c bursting charge of from 10 to 14 pounds, while that of M. Krupp is four pounds.

[1] Large ingots of cast steel are forged out into flat lengths, from which are cut rect pieces corresponding with the weight of the proposed tire. These pieces are forged i which are split down the centre to within a certain distance of each end; wedges a driven into the slot, and the bars gradually opened out and worked under the hamme ring, which is ultimately finished in the rolling mill.

That the manufacture of these homogeneous cast-steel guns is improv- ıg there seems to be little doubt, and in this special branch the business one at Essen clearly shows that M. Krupp occupies the first place in urope. An establishment that can produce 60,000 tons of finished steel nnually, may reasonably be expected to bring its productions to the ighest attainable degree of excellence in less time than smaller con- erns, and if these weakening breech-arrangements could be dispensed ith, cast-steel guns would doubtless soon supersede the complicated oiled wrought-iron systems. The want of confidence in steel guns is ot attributable to any inherent defect in the metal so much as to the bsurd fancies introduced by their designers, and which on trial have requently resulted in disastrous failures. That steel, under the most rying circumstances, is daily proving its reliability, is evinced in the ase of the rails, tires, and crank-shafts used for railroad purposes. he odium which seems to stick to steel guns did not originate in the xcessive number of guns burst, but in the nature of their destruction. he life of a Woolwich gun (perhaps the best of the wrought-iron ype) is about 400 rounds. By a parliamentary report, up to April, 366, 20 out of 33 7-inch Woolwich guns, upwards of 60 per cent., ere either burst or rendered totally unserviceable by an average of 10 rounds. No such record of failure can be produced against the uns of M. Krupp. The chief indictment brought against them is, that ey burst explosively, while the wrought-iron gun dies gradually, like ne in a decline. It succumbs without noise, frightening nobody, whilst e other (like a sudden and untimely death) demoralizes all who behold nd survive its destruction. A mild, tough metal, that will more effec- ally resist such explosive action, is the grand desideratum with the akers of steel guns. That such a metal is attainable there can be little oubt, nor is there any quarter from which there is no more reason to xpect its appearance than the establishment of the great gunmaker or ssen.

GERMAN AND SWEEDISH GUNS.

Krupp, however, is not the only maker of steel guns in the Exhibition. e is not even the only German maker. Berger & Co., of Witten in estphalia, mentioned in connection with "Field Ordnance," have also me guns of large calibre. The largest is an 8-inch breech-loader, mewhat similar to Krupp's, and which appears to be more simple. See woodcut.) The wedge or closing breech-block A has a flange, *b*, e rim of which is partly cut away to allow it to pass a notched keeper- ock C, and when the wedge is pushed home a half turn of the handle rings the uncut part of the flange into the notch of the block C, and at e same time, and with the same movement, a screw acts upon a tight- ning wedge, or key, which effectually jams the breech-piece, and closes e breech. Many of the guns for the Prussian and Russian govern- ents have been made in the factory of Messrs. Berger & Co. But the putation of this firm is *chiefly* due to the production of steel gun-bar-

rels for the Prussian army, the needle-gun being, almost without exception, provided with barrels of Berger's make, drilled out of the solid bar. Engineering considers that Berger's steel is fully equal to Krupp's in quality, and that his small gun-barrels, especially, are more uniform in quality than those of any other maker.

Berger's [illegible] m breech-loader.

A hooped, soft-steel gun, of 16 tons in weight, is exhibited by the French firm of Petin & Gaudet. This gun is about 18 feet long, of 9½ inch bore, and is intended to carry a shot of 300 pounds weight. Messrs. Petin & Gaudet, as before stated, are the principal makers of steel hoops and trunnion rings in France, and if they are as successful with their heavy steel ordnance as they have been with their reinforce rings for large cannon, their soft steel guns may do much to bring to greater perfection this branch of the munitions of war.

The guns in the Exhibition which come nearest to our own in shape, and perhaps in the quality of the metal, are two cast-iron "Finspong" guns, exhibited by the government of Sweden. One is a smoothbore, of 11 inches, without any reinforce, and the other a four-grooved rifle of nine inches, with a steel reinforce at the breech. The test to which these guns is subjected is of the severest kind, as the following, applied to a 9-inch smooth bore, testifies. Two rounds are first fired with 30-pound charges and a shot weighing 160 pounds; then the charge is increased to 40 pounds, at which it continues throughout the trial. But, after one round with the same weight of shot, five rounds are fired with two shot, or 320 pounds weight. Then five rounds with three shot—equal to 480 pounds weight, and five with four—equal to 640 pounds weight of metal. A shot is then added every round till they fill the bore—numbering eighteen shot—2,880 pounds; all of which the gun stands without giving way. Compared with such a trial, the proving of the wrought iron, tube-lined guns at Woolwich is mild in the extreme.

Sweden was one of the first countries that produced cast iron cannon. As early as 1568 the Swedish navy was armed with cast iron guns. The ores of Sweden have long been famous, and the Swedish guns soon acquired a renown for their excellent and enduring qualities, and during the seventeenth and eighteenth centuries the greater part

'the states of Europe purchased their cannon in Sweden. The ores of rtain districts, especially, possessed the necessary qualities for furnishg a superior and solid casting. But the exportation of so many guns iring the above-mentioned period led to the erection of a great many innon foundries, and, as already observed, many of these made use of ferior ores. The consequence was that many of the guns burst, and the putation so long enjoyed by Sweden, and to which she was justly entitled, gan to decline. The necessity for a rigid inspection of ores was thus rced upon the Swedes, when it was found that certain mines only rnished ores that were suitable for the fabrication of cannon. This used the decline of many foundries, and Sweden very soon began to gain the reputation she had lost through inattention to the materials ed in the manufacture of her guns. Now, her cannon founders are t satisfied merely with the most searching selection of their materials, it by great perseverance and study in the perfection of their works ey are endeavoring, with a great degree of success, to produce cannon hich for strength and durability will surpass the cast-iron guns of her countries.

In bringing our report on "Heavy Ordnance" to a close, it is but right say, that all the heavy guns exhibited have not been mentioned. iere are cannons from Russia, Belgium, and other countries, which ve been passed by because they contain nothing special in regard to e mode of their manufacture, or their working arrangements.

Considered in regard to the materials used in their construction, the ins we have commented on may be divided into three classes, namely, st-iron, cast-steel, and wrought-iron guns. The cast-iron weapons are presented chiefly by the French and Swedish guns, the former being eech-loaders and the latter muzzle-loaders. We have recorded the rticulars of the test to which the Swedes subject their cannon, and ough those of the French may be equal as regards the quality of the etal used, we do not believe that their breech-closing arrangement ould stand such a test. The cast-steel guns exhibited are chiefly eech-loaders also, all greatly weakened and more or less complicated, d enhanced in cost by an arrangement of doubtful advantage. The ought-iron system, of which the British government and Sir W. Armong are the chief exponents, has not, especially in the larger calibres, en saddled with the breech-loading difficulty, and if these guns could ly live a reasonable number of rounds, their immunity from explosive rsting would give them a great advantage in war. Men will always ke more kindly to a gun that gives them warning of approaching struction before exploding in their hands, but 400 or 500 rounds is too ort an existence for such costly weapons. The Whitworth gun, with homogeneous tube, and weldless hooping, though not wholly secure ainst explosive bursting, is, perhaps, for calibres up to seven inches, e strongest and most enduring gun we have examined. It is second none in accuracy of firing, whilst in range it far surpasses everything the Exhibition, except the "Ferris gun" in the American section.

CHAPTER V.

PROJECTILES.

NEW INVENTIONS—PALLISER PROJECTILES—OBLIQUE FIRING—PALLISER AND WHITWORTH 7-INCH SHOT—ACCURACY—SHARPNELL AND SEGMENT SHELL—PARACHUTE LIGHT-BALL—WHITWORTH CASE-SHOT—GUN-COTTON—EXPLOSIVE RIFLE BULLETS.

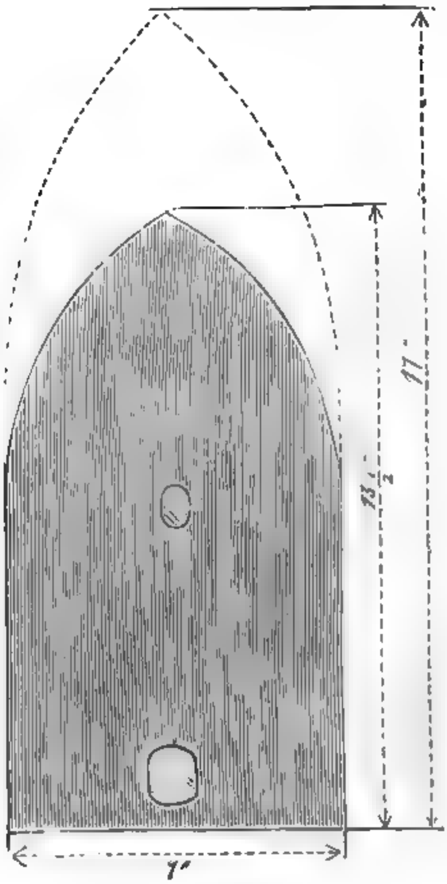
NEW INVENTIONS.

Having frequently referred to shot and shell in speaking of the guns, there remains little to be said under the head of "Projectiles," save to notice anything specially new and interesting. We are daily hearing of some terrible missile that is to make an end of war by destroying everything within its range, but which, when closely examined, or subjected to a trial, is often found to be inferior to well-known projectiles in general use. As an illustration of these a single case will suffice. A Monsieur Landi, of Paris, exhibits a cartridge that fires many shots ("*La cartouche a plusieurs coups*") at one loading. He proposes to fill the barrel of the gun with cartridges put together like a candle or a rod, and which by some very complicated process are to be fired off in succession. The first is to be fired from the muzzle, and it communicates the fire by means of a slow match to the next below it, and so on till the whole are fired. Round bullets and smooth-bore guns are necessary for this extraordinary cartridge. M. Landi evidently never heard of rifled breechloaders, and doubtless took his idea from the common Roman candle used in pyrotechnical displays, for he contends that his gun, once loaded, can be levelled as when advancing to charge, and while the soldier is running the gun will keep firing without reloading, or the necessity of pulling a trigger.

PALLISER PROJECTILES.

Passing by this and dozens of useful and well-known war missiles, we come to the projectile of projectiles, judging from the large sum of money which the British government paid to the inventor—the Palliser chilled shot. The British war department, in a "Hand-book of Instructions," says that "in the manufacture of this shot," (we quote from memory,) "care must be taken to select such brands of iron as will *chill through.*" Before Major Palliser discovered the process of "*chilling through*" a solid shot of nine or twelve inches in diameter and from 250 to 600 pounds in weight, engineers and iron-founders considered from a quarter to three-eighths in depth a very good chill. But, in truth, the Palliser shot are not *chilled* at all, they are the very antithesis of chilled, they are annealed. The hardness of this shot is due to the nature of

'hite metal furnished by the Ebbw Vale Company, and not to the mould in which the shot is cast. It is well known that a chill is ıced by running the molten metal into a cold iron mould; but this ı metal is so hard and brittle in its nature, that if run into a cold d it would crack so as scarcely to hold together when taken out. e the Palliser mould, instead of being cooled to chill the shot, must ated to prevent the metal from cracking. Even when the shot is ı out of the mould it must be buried in hot sand to prevent its crack- y being too suddenly cooled. "Chilled shot," to the inventor of ı the British government paid $75,000, is therefore a misnomer. made from Pontypool iron or white metal, cast in sand in the ordi- manner, are equal in penetrating qualities to those which Major ser casts in iron moulds, and have the advantage of being produced ıch less cost, as six of the former, so far as labor is concerned, can oduced as easily as one of the latter. The shot cast in sand from



Palliser shot, with head of shell in dotted lines.

ıetal sometimes show as if unsound, having a cracked appearance ıe outside, which may be accounted for by the fact that the cool-

sand is really a better "chill" than the hot iron mould used at Woolwich. The Palliser shot exhibited by the war department and by Sir William Armstrong have all been cast in iron moulds; they are split open to show the texture and color of the metal, but it is impossible to trace even the faintest outline of a chill in any one of them, save in the core of one of the shells, where the metal has the appearance of being chilled about of an inch deep. Mr. Whitworth shows a shot made for his guns of the same metal, also broken in two. It was cast in sand, and is evidently a better casting, both as regards the skin of the shot and the closeness of the metal, than any other shot of this nature exhibited.

Leaving the metal of the Palliser shot, we come to consider how far its form is conducive to its efficiency, first, as to penetration, and second, as to accuracy. The penetrative power of the Palliser shot, when fired at a right angle to the plate, is perhaps greater than that of any other projectile, other conditions being alike. This is due, in conjunction with the hardness of the metal, to the ogival form of the head, which is illustrated in our woodcut. Without entering upon the theory why this form of shot in direct firing has such penetrative power, we may observe that this power diminishes more rapidly than that of the flat-headed shot, when the firing is more than 30 degrees from a rectangular line. The Palliser shot of 115 pounds weight, fired from the Woolwich 7-inch gun with 15 pounds of powder, passes easily through an unbacked plate of soft iron seven inches thick at 70 yards range. But at an angle of 30 degrees, the same shot with 22 pounds charge invariably fails to pene-

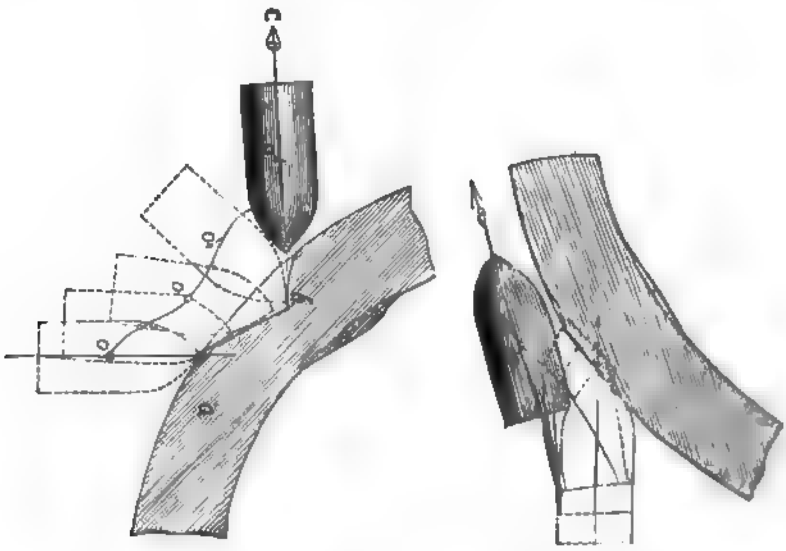
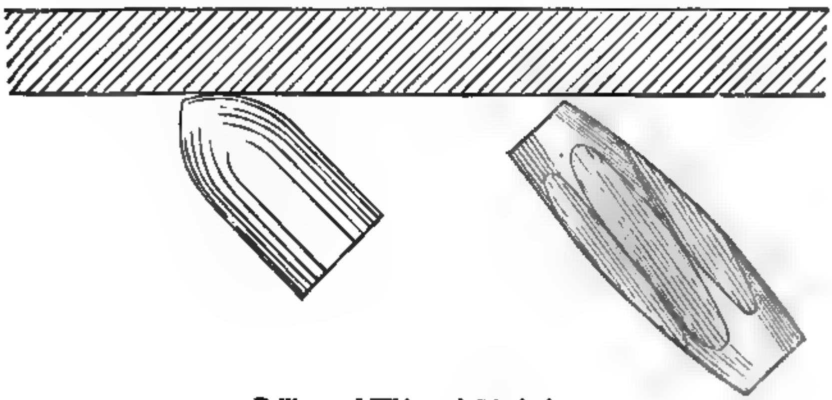


Fig. 1. Fig. 2.

trate, whilst at an angle of 45 degrees its effect would be almost nothing. *Figs.* 1 and 2 are sufficiently near what the experiments have established

to give a fair idea of the effects which these shot are likely to produce on cupolas and turrets, save when, as it were by accident, they happen to strike at a right angle. In Fig. 1,[1] the point striking at an angle of about 35 degrees, has caught at *a*, when the bearing on the impinging shoulder gradually cants the shot, till at *b* it loses its hold and flies off in the direction of the arrow *c*. In Fig. 2, the shot striking at a greater angle, merely glances off in an oblique direction from the line of fire. The action illustrated in Fig. 1 shows that the shot has a tendency to right itself, if the angle be not too great, but this righting action is also a jamming action, which fully accounts for the greater falling off in penetration by a departure from a direct line as compared with the flat-ended shot. The Whitworth flat-headed 7-inch shot has frequently penetrated a four and a half inch plate placed at an angle of 45 degrees. The following sketch, in which the Palliser and Whitworth 7-inch shots, on a scale of an inch to a foot, are seen impinging on a four and a half inch plate at an angle of 45 degrees, will show that the point of the former cannot possibly catch until the friction on the impinging shoulder has made the rear end of the shot swing about 10 degrees to the left. The momentum thus imparted to the rear and heaviest end of the shot will



Palliser and Whitworth 7-inch shot.

carry it round with the same result as shown in Fig. 1, in spite of the resistance offered by the metal it may scoop out. The latter, on the other hand, bites at once—cuts like a chisel or gouge, destroying the resistance of the plate in detail, and going clean through on a line almost

[1] Fig. 1 (says *The Engineer*, from which our diagram is copied,) illustrates what may happen when the convex surface is obliquely struck under conditions which enable the point of the shot to catch without holding, and the axis of figure to turn through a certain angle, as while the centre of gravity is passing from *o* to *o′*, or a little beyond, during all which period the ogival point continues to excavate by its forward side only; the other not being exposed to any pressure from the solid, and the oblique direction of the translative velocity of the shot being such that though the interior face of the plate may be bulged, the *umbo* is so much obliquely in advance of the shot that the latter does not penetrate. * * The axis of figure rapidly is wheeled round into the position at *o″*, and thence to *o‴*, when the shot flies off with its base at first foremost in the direction of *o‴ s*.

parallel with the flight of the shot. It thus appears that the cupolas of Monitors and sloping sides of ships like the Dunderburg have little to fear from Palliser shot, and even the roll of an iron-clad in a moderate seaway will impart such an angle to her sides as will give a large percentage of protection against these projectiles.

Some writers, both English and American, contend that at long ranges the line of trajectory will be such that the shot will strike almost at right angles to the plate, on the sloping side of a ship, thus neutralizing the advantages claimed for this method of construction. But at this point the shot has lost too much of its velocity to effect penetration. Penetration demands a high *velocity*, not a high *trajectory*, and a high velocity for a shot aimed at a low mark implies point-blank firing or very little elevation.

The Palliser shell, if shell it may be called, has, as we have shown, a head more pointed than the shot, but owing to the brittleness of the metal used the sides must be very thick, and therefore it carries an insignificant bursting charge. For the 7-inch gun it is under two pounds, and for the 9-inch gun under four pounds. The metal of the shell breaks up in passing through a plate of moderate thickness, so that by the time it reaches the backing it has ceased to be a shell. The powder therefore of the bursting charge being unconfined, rarely does much damage.

ACCURACY OF THE PALLISER PROJECTILES.

To the second point, accuracy, we have already adverted when speaking of the Woolwich guns. We did not intend to bring a charge of indifferent firing against the guns themselves, but gave some facts to show that when firing Palliser shot the accuracy was very indifferent. A report of some experiments with Palliser guns and shot made in September[1] appeared in the Standard, at the time, and was evidently written by a friendly hand:

"And now," says the writer, "came the most interesting event of the day, the trial of Major Palliser's converted guns. The first was a 64-pounder rifled muzzle-loading gun converted by the insertion of a wrought iron tube from a 32-pounder cast-iron gun of 58 hundred weight. The range was 500 yards, and the target was the 'Warrior,' No. 22. The charge used was 16 pounds of powder, with a Palliser 84-pound shell filled with a bursting charge of 17 ounces. The first shot was in good line, but the elevation was rather too great. The shell just missed the top of the target, and striking a bolt in some heavy woodwork behind buried itself in fragments in the timber. The second shell struck the target on a sound spot 3 feet 11 inches from the lower right-hand corner, passed through the 4½-inch plate, and was there broken on one of the ribs of the inner skin, which, however, was not broken, though a part of the timber backing was driven into matchwood. The estimated

[1] Since this date the accuracy of these guns has been improved by lengthening the shot about one-seventh.

force of impact of this shot was 45 tons per inch of circumference. The third shot ever fired from this gun *caught* the target at the upper right-hand corner, 14½ inches from the right side, and 29 inches from the top."

The writer evidently breathed more freely when the shot *caught* the target.

"The fourth shot, which was fired at No. 28 target, had a little too much elevation, and only punched a bit about half its own diameter out of the upper edge of the target, which there is no doubt it would have penetrated had it struck fair. It was now nearly half-past 5 o'clock, and it became necessary to cease practice for the day. This morning the programme will be resumed and completed. Among the experiments to-day will be one to ascertain the respective range and accuracy of Palliser shot with long and short heads, and with a reduction of windage. Forty rounds will be fired altogether, with charges of 22 pounds, at 3 degrees and 5 degrees elevation."

These experiments, for some reason or other, have not been reported in *The Standard.*

The above guns were rifled on the Woolwich system, the twist of which may not suffice for very long ranges, but at moderate distances the firing (before the Palliser shot in its present form was adopted as the national projectile) was very respectable. Referring to a "Report on the trial of rifled guns, June, 1865," submitted to Parliament, we find the ordnance select committee saying:

"The particular object of the experiment was to ascertain if possible whether the smaller stud, which in the French system is situated behind, but in Major Palliser's plan, as tried in the Woolwich gun, is placed in front, contributes to accuracy by assisting to rotate the shot, or only by preventing its oscillation in the bore. To test this, the smaller stud which was in front, and, as intended by Major Palliser, ought to give rotation near the muzzle, was very much reduced in size, in the expectation that it would not touch the driving edge. An examination of the shot after their recovery shows that this expectation was not realized; the smaller studs are all worn, and evidently took the rifling. So far, therefore, the object of the experiment was not answered, but the practice is of some importance in support of the committee's recent recommendation of this mode of rifling."

The following minute is then given: 20 shells filled with sand and plugged, 100 pounds; charge, 20 pounds; elevation, 5° 7′.

Mean recoil.	Mean time of flight.	Ranges.			Mean difference of range.	Mean observed deflection.	Mean reduced deflection.
		Minimum.	Maximum.	Mean.			
Feet.	*Seconds.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
3	7.36	2,648	2,727	2,700	13.8	11.3	2.1

The committee add that "the uniformity of this practice is remarkable, and it has been but seldom exceeded," and after giving a table of 20 experiments with other guns, including the breech-loading Armstrong, the shunt, and Scott guns, they say, "the committee do not desire to lay too great a stress upon a single example of very good shooting, but as the merits of the Woolwich system of rifling are still under consideration they beg to add the foregoing practice to the record."

From these, and other evidence that could be adduced, it is clear that the recent indifferent firing of the Woolwich guns with Palliser projectiles is due more to the shot than to the gun. To obtain the ogival form of head best suited for penetration with the white metal of the Palliser shot, the bearing of the shot has been greatly shortened, which, with the insufficient spin consequent upon a slow twist, originates and keeps up for a time the wobbling motion already commented on. This defect might be obviated by lengthening the shot, but that would increase its weight and diminish its velocity, which latter is especially essential to its penetrative capacity. At the moderate striking velocity of 900 or 1,000 feet per second, which after all is that most likely to prevail in actual conflict, it is presumable that the hard-metal shot with the ogival head would expend, proportionately, a greater amount of the work it contained on its own destruction, than at the higher velocities attained at the Shoeburyness experiments.

In alluding to heavy rifled ordnance generally, we have spoken of the British government, in having adopted these weapons exclusively for their naval armaments, as "putting all their eggs into one basket." The ordnance select committee seem to think that so far as their shot is concerned they will be costly and troublesome "eggs" to transport. "The supply of rifled projectiles," they say, "will always be limited from their bulk and weight and cost. It is not to be expected that they will be expended so freely as round shot, which will also be good enough for instructional and other purposes, and can be carried in any desirable quantities." The committee here refer to the firing of round shot from rifled guns, but such shot, from the small calibre of the guns, will be very harmless missiles against armor plates.

SHRAPNELL AND SEGMENT SHELL.

The ordinary service shrapnell shell which was tested against the Segment shell (invented by Sir William Armstrong) at the Armstrong and Whitworth trials, is shown in the collection of the laboratory department of the Woolwich arsenal. Fig. 1 represents this shell in section. The ignition is regulated by a time fuse which fires the charge at the base of the shell. The explosion breaks away the thin head, sending the bullets forward with a force as if fired from another cannon. Fig. 2 is the Armstrong segment shell, the square pieces or segments of which are scattered by the bursting charge. The following table of experiments with these shells at the Armstrong and Whitworth trials shows

some curious results. The shells were made to strike a screen so as to explode at the required distance in front of the targets; the shells to

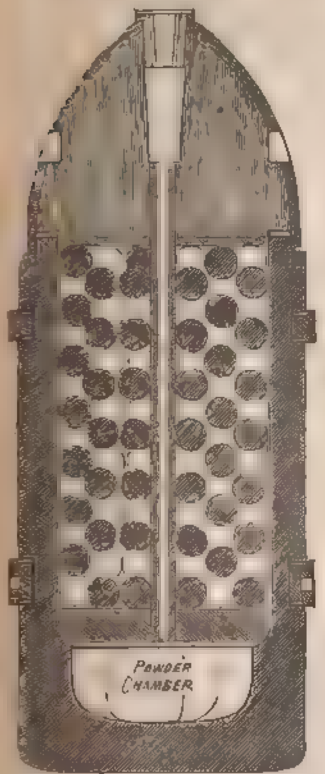


Fig. 1.

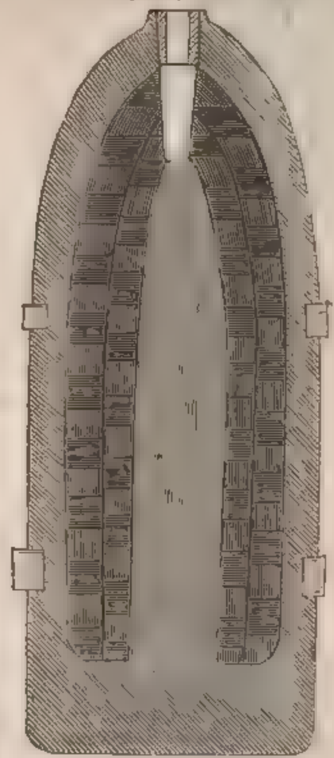


Fig. 2.

strike the screen at various heights from the ground up to 10 feet. Concussion fuses were used at this trial.

"Practice with Whitworth shrapnell and Armstrong segment shells: Area of target face 27 ft. × 9 ft., except at the 800 yards range, when, for the latter rounds at 50 yards burst, there was an increase of three targets, making 54 ft. × 9 ft. face; at the 100 yards burst, the area of face was increased to 72 ft. × 9 ft. 2 in. thick."

RANGE, 600 YARDS.

Number of rounds.	Distance of targets in front of burst	Whitworth M. L.			Armstrong M. L.		
		Through	Lodged	Struck.	Through.	Lodged.	Struck.
	Yards.						
10	25	350	45	8	388	93	57
10	50	224	18	18	151	41	16
10	100	113	24	61	43	68	62

RANGE, 800 YARDS.

Number of rounds.	Distance of targets in front of burst.	Whitworth M. L.			Armstrong M. L.		
		Through.	Lodged.	Struck.	Through.	Lodged.	Struck.
10	10	603	36	17	546	68	9
10	25	540	41	12	388	174	6
10	50	348	21	15	167	157	8
10	100	296	33	7	86	160	6

There is reason to believe that the ranges of these tables ought to be reversed, otherwise both have done greater damage at 800 yards than at 600 yards. The shrapnell and segment are nearly alike as regards the number of hits in the 70 rounds, the numbers being respectively 2,772, and 2,669, but the through hits of the shrapnell are 2,406 to 1,649 of the segment.

PARACHUTE LIGHT-BALL.

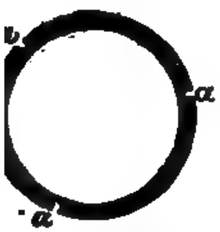
Parachute light-ball

To merely mention the various projectiles exhibited in the Exhibition would occupy a considerable space. The case of the laboratory department of the Woolwich arsenal alone contains about a thousand different pieces, sections, &c., chiefly relating to projectiles, cartridges, and fuzes. It contains round and cylindrical shot of various sizes and kinds, in short, a sample of nearly every shot and shell used in the British service. There are shell and sections of shell, segment and sharpnell charged and empty, spherical and diaphragm, mortar and liquid shell, besides rockets, smoke balls, and signal lights. A specimen of almost every article produced in the laboratory department is exhibited in this case. Among these, a parachute light-ball (10-inch) is especially interesting. It is a hollow sphere of thin iron (about a quarter of an inch thick) enclosing

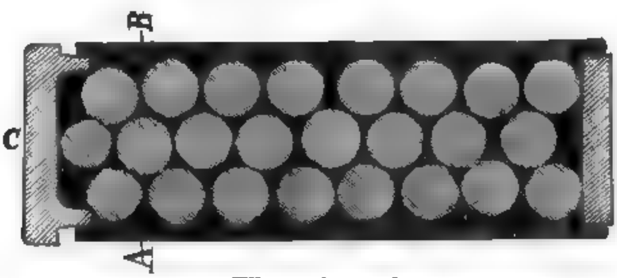
a thinner shell made in two halves, and lightly fastened together. In the lower or permanent half of the inner shell is a peculiar illuminating compound, and in the upper half a parachute of thin cotton is snugly stowed. The ball is fired from a mortar, with a light charge, so as to reach a point over the enemy's works, when a time fuze ignites a small bursting charge which throws away the outer shell, and the upper half of the inner, thus freeing the parachute. The parachute, to which the lower half of the shell is attached by lines and small chains, (the latter next the shell so as not to be burned,) expands and slowly descends, while the illuminating compound, which has been ignited by the bursting charge, lights up the surrounding country. This compound burns for a space of about three minutes, and so illuminates the enemy's works that any operations undertaken under cover of night are detected. The woodcut on page 130 represents the parachute light-ball immediately after the explosion of the bursting charge, and the expansion of the parachute.

WHITWORTH CASE-SHOT.

In the adjoining building Mr. Whitworth shows various specimens of his common case-shot, the effects of which have already been referred to and illustrated by a diagram. This projectile, or rather collection of projectiles, consists of a thin metallic shell, filled with bullets as shown



Cross section on A B.



Whitworth case-shot.

in the wood-cut. The space between the bullets are filled with rosin to keep them in position. The case is weakened, as shown at *a*, *a*, *a*, cross-section, to facilitate its breaking on leaving the gun; and in order to render this certain, the cap *C*, which is not pushed or driven home before loading, has as much taper as suffices to open or split the shell, when the freed bullets, which keep pretty well together, produce an effect, at from 200 to 500 yards, similar to that of a well-concentrated charge of small shot from a fowling-piece.

If a projectile of this description—each internal sphere being a percussion shell instead of a solid shot—could be used in our 15 or 20-inch guns, the effect on anything but an iron-clad would be terrible, especially at short ranges. Even against iron-clads they would make fearful havoc on the deck, besides having a good chance of entering at the portholes, especially such hopper-shaped portholes as those of the British iron-clads "Hercules" and "Penelope." Such projectiles could only be fired

with advantage from smooth-bore guns of large calibre; they are not rifle projectiles; if any spin were given to the case before it breaks up, it would have the effect of scattering the shot, and a case fired from the small bore of a rifled cannon of the ordinary size would not contain shells of sufficient capacity. A case two feet long, suited to the bore of our 15-inch guns, would contain 12 spherical shells of six and a half inches diameter, each of which, being one and a quarter inch thick, would contain a bursting charge of rather more than two pounds of powder. Such a case-shot would weigh about 650 pounds.

GUN-COTTON.

Before closing these hasty remarks on projectiles, a kindred subject—gun-cotton—demands a passing notice. Many who have suffered more from the deleterious than the explosive effects of "villainous saltpetre," hoped that the Exhibition of 1867 would throw more light than it is likely to do on the subject of explosives. Messrs. Thomas Prentice & Co., of London, who three years ago established a factory for the purpose of preparing gun-cotton, according to the Austrian process, under the inspection of Baron Lenk, show a varied supply of this explosive, chiefly made up for sporting purposes. Baron Lenk, an Austrian general officer, has been unremitting in his endeavors to bring the preparation of gun-cotton to perfection, and Professor Abell, F. R. S., director of the chemical establishment of the British war department, considers that Baron Lenk's improvements "contribute importantly to the production of a thoroughly uniform and pure gun-cotton." A full inquiry into a subject that has engaged the attention of scientific men for 20 years would greatly exceed the limits of this report. Therefore we merely give, in the words of the exhibitors, the advantages which they claim for their gun-cotton for military and naval purposes:

"For purposes of artillery"—1. "The same initial velocity of the projectile can be obtained by a charge of gun-cotton one-fourth of the weight of gunpowder. 2. There is no smoke from the explosion of gun-cotton. 3. Gun-cotton does not foul the gun. 4. It does not heat the gun to the injurious degree of gunpowder. 5. It gives the same velocity to the projectile with much smaller recoil of the gun. 6. Gun-cotton will produce the same initial velocity of projectile with a shorter length of barrel. 7. In projectiles of the nature of explosive shells, gun-cotton has the advantage of breaking the shell more equally into much more numerous pieces than gunpowder. 8. When gun-cotton is used in shells instead of gunpowder, one-third of the weight of the latter produces double the explosive force." "For naval warfare," "Where guns are close together, as in the batteries of ships, the absence of smoke removes the great evil of the firing of one gun impeding the aim of the next, and thus gun-cotton facilitates rapid firing."

The summing up of the general advantages concludes as follows: "The patent gun-cotton has the peculiarity of being entirely free from

the danger of spontaneous combustion, and it is constant and unalterable in its nature." The above, of course, is from an advertising circular, but if a tithe of the advantages here put forth will stand the test in practice, Baron Lenk and Messrs. Prentice & Co. will have earned the gratitude of every son of Mars.

EXPLOSIVE RIFLE BULLETS.

There is still another class of projectiles in the Exhibition which we might perhaps have passed *sub silentio*, but for the fact that an inventor of this class of missiles has been paid a considerable sum of money as a reward for his invention by a prominent European government. We allude to explosive rifle bullets. Some experiments have been made in Paris this summer with these projectiles, (in this case a French invention,) when one of these bullets burst in the heart of an oak plank, eight inches in thickness, breaking itself into five fragments, and tearing the plank to pieces. Such a bullet lodging in a limb, if it did not shatter it so as to cause the wounded soldier to bleed to death, would certainly inflict such pain as would be tantamount to unnecessary cruelty and torture; for the jagged fragments of the exploded bullet would, on the explosion, take a course through the flesh as erratic as their form is irregular, and thus prevent them from being probed or removed. Many a wounded soldier has lived for years with a bullet in his body or his limbs, and has after a time suffered but little inconvenience from it, and thousands who have lost limbs altogether, like England's great Admiral, and many in our own country, have done the state and mankind good service after they were maimed. But such would seldom be the case with wounds inflicted by the jagged and ever-tormenting splinters of an explosive bullet. Any torpedo that would sink a ship of war or even a fleet of ships by a single explosion, or any projectile that would sweep away whole battalions at once, would be hailed as a welcome means of shortening the horrors of war; but no such feelings are awakened by contemplating explosive bullets for small-arms. Such missiles must ever be classed with poisoned arrows or any other hellish contrivance that will enable men to kill rather than cure the wounded. Explosive bullets, such as those referred to, will never tend to shorten wars. By doing away in a great measure with the necessity for taking care of the wounded, soldiers after a battle will be less frequently brought together to look after their suffering and disabled comrades and bury the dead—solemn duties, which, by appealing to our better nature, often lead to a cessation of hostilities and sometimes bring about a lasting peace. During the late war, when certain ladies applied to General Sherman for permission to go to the front to attend to the wounded, the general in granting their request said: "It is not necessary for me to say to ladies in your position, that in administering relief to the wounded soldier no distinctions are to be made." "I feel sure," he added, "that you will never ask a wounded soldier whether he is friend or foe, before granting him such

assistance as it may be in your power to render." Such sentiments as these, which teach us to pray that God would have pity upon all prisoners and captives, not only tend to mitigate the evils of war, but bind people together in union and friendship after a war is ended. They are diametrically opposed to the spirit that originates and employs explosive rifle bullets and poisoned arrows in our day, or that which in ancient times made conquerors drag their captives at their chariot wheels.

CHAPTER VI.

ARMY ACCOUTREMENTS, ETC.

BRITISH SECTION—IRON-BAND GABION TENTS—SOLDIER'S CLOAK-TENT—NEW KIT BAG—ARMY TELEGRAPH SIGNALS.

BRITISH SECTION.

The exhibit of army accoutrements, and the sundries that go to make up the machinery and necessaries for the transport and maintenance of armies, are, with one or two exceptions, very meagre and commonplace.

In all that pertains to the care, transport, and relief of the wounded the collection of the "International Society for the Relief of Wounded Soldiers," and that of the United States Sanitary Commission, exhibited by Dr. Evans, leave little to be desired. The British war department not only exhibit all that is new and interesting in war material, but everything calculated to illustrate the every-day life and exercise of the soldier in every branch of the service. Not only is a soldier's barrack-room exhibited with lavatory and water-closet attached, but a hospital ward with ordinary furniture and conveniences—lavatory, bath room and closets. There is also a married soldier's quarters, and a room in which are articles used in the soldier's recreation-room, such as draughts, chess, and bagatelle boards. Another room is devoted to gymnastic exercises, all the paraphernalia of which—dumb-bells, clubs, single-sticks, foils, &c.—are shown. In the park adjoining the building containing the munitions of war are exhibited a two-stalled stable, and the heads and points (of the well-known Prussian type) used in cavalry exercise. Within the building are specimens of twelve different kinds of swords and cutlasses, which have been and are now used in the service. Admiral Farragut, on being shown this collection, selected a cutlass which he said was the same as that used in the United States navy when he entered the service; and the non-commissioned officer in charge said that "the same cutlass was in use in the British navy now," having outlived many attempts to supersede it by more showy but less handy weapons. It is a cutlass with a very slight curve, and a simple bow guard. The British war office museum at Paris is not limited to the display of made-up war material, such as we have described, but it contains samples of nearly every nail and screw in the service. On the sides of two hexagonal trophies, about five feet in diameter and twelve feet high, are arranged a sample of all the tools supplied to the different trades——"carpenters, shoemakers, farriers, shoeing smiths, bricklayers and masons, coopers, tailors, wheelers, collar-makers, pioneers, miners, camp equipage, and picketing."

Leaving the general review of this collection, which, although possessing much that is intrinsically excellent, would, perhaps, have been more interesting if less of what is commonplace had been exhibited, we pass on to notice such of the exhibits as may possess some novelty or excellence entitling them to special attention.

IRON-BAND GABION.

Iron-band gabion.

Some iron band gabions (galvanized iron) invented by Quartermaster Jones, of the Royal Engineers, have attracted a good deal of attention. They consist of bands of hoop-iron about three inches wide, interlaced with light wooden laths, as represented in our wood cut. The bands are formed into a hoop, and each being prepared for a stud and slot, or button and button hole joint, they are easily put together. This gabion, in the absence of wooden laths, can be constructed of rods or wands of any tough wood. Several experiments have been made with it in England, but it has not yet been adopted in the service, the splinters from the iron hoops being considered a source of greater danger than the shot of the enemy. On the inner slopes of an earthwork they might render good service, with less danger to the defenders. A bridge constructed chiefly of these bands is represented by a photograph of one actually built as an experiment. This bridge consisted of eight belts or suspending chains of hoop-iron, connected lengthwise by swivel screw joints. Upon these chains or belts was laid a floor of timber planking. This experimental bridge was 100 feet long and eight wide, and had a deflection of four feet three inches. It required 672 bands disposed, as stated, in eight bearers, 21 bands in length, and four in thickness; and 352 bolts, nuts, and washers were employed in its construction. The weight, including superstructure, was 5,067 pounds, and the breaking weight 19 tons. It was constructed by two non-commissioned officers and 32 men, in six hours, and was, on the whole, considered sufficiently satisfactory to be adopted in the engineering branch of the service. So materials for several bridges of this sort, with suitable anchors, form part of the regular *equipage* of the British army.

Near by stands an armorer's field equipage, with forge and vice-board complete, the whole not occupying more than 5 by 3 feet of superficial space. The tool-chests are evidently contrived for convenience of transport, being only about 12 or 14 inches deep, about two feet wide and three feet long.

The adjoining case contains a complete display of the fire-arms manufactured at Enfield; it not only includes the various service guns, converted on the Snider system, but specimens in the rough and finished of the several parts of each, with the necessary tools for their manufacture. These parts being identical in each piece render the duties of the armorer, who is supplied with them finished, comparatively easy. Perhaps in no country but our own is this adherence to systematic construction so rigidly followed as in England. But long before the division of labor which such system implies prevailed in the manufacture of clocks and other wares in America, it had taken deep root in England, where, over a century ago, it took ten men to make a common pin. The same range of show-cases contain model figures dressed in the several uniforms of the service, among which is one of white linen for native Indian and other troops located in tropical climes. It has a cheerful appearance, and in countries where long spells of dry and warm weather prevail, this uniform will be highly prized; still, in variable climates, like that of most of the southern States, especially during such campaigns as those which our troops passed through in the late war, it would soon lose its spotless whiteness, while it would be inferior for the bivouac and camping out to colored woollen clothing.

TENTS.

In the matter of tents, there is nothing specially interesting in the British section save a hospital tent, which, for completeness and the protection and comfort it affords to its inmates, has no superior on the Champ de Mars. This tent is double throughout, with ventilating apertures so arranged that, while they admit of a free circulation of air, they effectually keep out the rain. It is similar in shape, though somewhat larger than the double tent used in the United States service. Indeed, the chief difference consists in the roof only of the latter being double, while this is double throughout. Still it is not much heavier than the American tent; when the latter is made in two halves to lace together, the extra ends almost make up for the canvas necessary to make the double sides of the English tent.

The speedy recovery of the sick, and consequent increased percentage of effective troops, depends in a great measure on the completeness of the hospital arrangements; for results of an enlightened treatment of the sick during a campaign will be subject to the same laws that govern like matters in permanent quarters. In 1857 the British government appointed a royal commission to inquire into the sanitary condition of the army, and they found that "in England the proportion of men con-

stantly sick is, at certain stations where improved constructions have been adopted, less than half the average number under treatment before accommodation was provided on the scale now considered necessary."

SOLDIER'S CLOAK-TENT.

Before, however, entering directly upon the sanitary phases illustrated in the Exhibition, a neat and convenient field or bivouac tent deserves to be mentioned. It is formed with the cloaks of the two soldiers who are to sleep under it. The material of these cloaks is a firm waterproof linen cloth, dyed blue, and has the appearance of the blouses worn by the French day laborer. The ridge of the tent (of which we give a woodcut) is formed by buttoning the edges of the cloaks together. The other edges are fastened to the ground by pegs, and the tent is kept up at each end by the soldier's musket or sword. This simple and unique contrivance, which provides a roof in a rainy night to every soldier, has been awarded a medal. It forms part of the collection of the government of the Netherlands.

Soldier's cloak-tent.

The French army tents, like the British, are bell-shaped, (*tents abri,*) with the eaves pinned to the ground; they are generally constructed for eight men, and cramped quarters they make, owing to the want of head-room. The French also show a store tent, with racks for bread, which, while they keep it off the ground and out of the reach of creeping insects, would make the bread hard and dry if kept any length of time. Outside of this tent is an oven, the floor of which is the natural surface of the ground, faced with a coating of clay. The sides and roof, about 13 inches from the ground, are formed of bent sheet-iron, having a door resembling an ordinary stove door, but rather larger.

In the private British section, Mr. Scott Tucker exhibits a shortened

which he claims the following advantages: First, that it is the ordinary bayonet; second, it is not so liable to the "crossing;" and third, that it can be carried in front, and will be more easily got at in action. The first advantage 'alue in the sense that "every little helps," for the entire present bayonet is only about a pound, while its length, in ixed bayonets, will not be any detriment to breech-loaders. 's bayonet is about half the length of the one now used, ys, "is, in good hands, long enough for all practical pur-

NEW KIT BAG.

'ement that promises greater relief to the soldier (not Paris, however) has been tried in the British army and o be eminently satisfactory. It relates to a new way of cnapsack and accoutrements, which will probably be intro- iection with the substitution of breech-loading for muzzle- -arms. (See woodcut.) A committee was appointed to :he effects of the present system of accoutrements on the infantry soldier, and in their report as noticed in the Stand- e:

nt campaigns, especially the Bohemian and Italian of 1866, is of the utmost possible importance to husband in every hing power and endurance of the soldier, whilst the intro- e breech-loading system compels the soldier to carry an he amount of ammunition in consequence of the greater ie fire which takes place. The latter necessity of course an increase of the weight already carried, unless some racting provision be made. The committee set to work to eight of the carrying apparatus (knapsack) as much as to distribute the weight absolutely required to be carried as to give the muscles of the chest wall and all the shoul- ree play. The weight that a soldier is compelled to carry, f the carrying apparatus, the rifle, the haversack for pro- bottle, and blanket, varies from 20 to 23 pounds, and is llows: The kit, (whose contents differ from those of the old omission of trowsers and blacking,) 6 to 7 pounds; the pounds; ammunition, 90 rounds, (the fullest amount to 10 pounds; the canteen, 1½ pound; the bayonet, 1 ng a total of from 22 to 24 pounds. On ordinary occasions ion might be carried. The weight of the carrying appara- reduced from 10 pounds 2 ounces to 4 pounds 3 ounces. mode in which the kit is recommended to be carried: the is discarded, and in place of it a bag is introduced; this is wn, and suspended from a leather yoke, similar in princi- lise proposed some time ago by Sir T. Trowbridge. The

weight of the kit bag is distributed in three directions: 1. The yoke, by means of straps passing before and behind to studs on the yoke. 2. To the large bone connecting the two hips. 3. And to the belt by means of additional straps. The weight of the ammunition is also distributed."

The committee have recommended the use of two long and narrow pouches, each capable of holding 30 rounds, and made of soft leather. In time of peace one only would be worn, exactly in front of the waist-belt, and suspended from the yoke. In time of war two would be worn, and, in addition, two small pouches in the kit-bag for ten rounds each have been made, and these might be filled, and ten more loose rounds would be contained in a little bag worn on the right side. The greatcoat is worn on the back, and strapped to the yoke. The new carrying apparatus, at all events, is about six pounds lighter than the old knapsack, and as far as the health and comfort of the soldier is concerned, the novel mode in which the weight is carried offers an immense advantage over the old system in every way.

ARMY TELEGRAPHY AND SIGNALS.

In the matter of signals and army telegraphy, the Austrians make the best display in the Exhibition. The advantages derived from the use of the telegraph during the Franco-Italian war of 1859, and during our own civil war, have led to the organization of telegraph trains in most of the European armies, and to the adoption of equipments specially suited to army telegraphy. Of the collapsing drum, the cone, the shutter, and other well known devices for signalling by daylight, it is not our intention to speak. The Austrians exhibit a signal apparatus, which consists of a pole about 20 feet high, having three disks of about nine inches in diameter arranged in the form of an equilateral triangle at the top. The two lower disks are moved by one handle, and the top one by another, so as to turn either surfaces or edges to the front. The messages are transmitted by displaying surfaces or edges in different positions. It is claimed that the use of three disks facilitates the communication, but, on the other hand, an alphabet different from the Morse, or other telegraph alphabet in common use, has to be employed. They also exhibit drawings of a lamp with a Drummond light and reflector, which is intended to illuminate the ground surrounding the point of observation. The lighting up of Fort Sumter at the distance of a thousand yards has led some military authorities to believe that this will be an effective apparatus of great value during siege operations, to the defending as well as the attacking parties. But though a stream of light can be turned for a long period on a given point, the source of light will always form a good mark for the guns of the enemy, whilst a parachute light-ball, like that previously described, if it only burns for a few minutes, does not reveal the position of those using it.

In electric telegraphy for war purposes the Austrian government are the most extensive exhibitors; but though they show, in apparatus and

drawings, various examples of their telegraphic equipment, they did not use them in any case during the late war with Prussia. They have hitherto been used only experimentally. The equipment, though light and portable, cannot be got into working order without considerable loss of time. The following extract from an able article in *The London Standard* will sufficiently explain the working arrangement:

"The central station is contained in a handsome, yellow painted square carriage on four wheels, and harnessed for four horses, very like a small light omnibus, the interior of which is fitted up as an office, with writing-table, pigeon-holes, and other conveniences, and into which the terminals of all the lines in communication are brought, and from which despatches to all out stations can, of course, be directed by the chief operator attached to the staff; the main object of the field telegraph being to maintain the headquarters of the commander-in-chief in constant communication with the telegraph of the State. The requisites are well horsed carriages, portable instruments, and a trained staff for the erection, manipulation, supervision, and demolition of the field lines. The principal carriage station is a regular telegraph office, from which the service can be commenced as soon as the line is finished, and wherever it may find itself. Nevertheless, these carriages have been latterly abandoned on account of their weight, and only apparatus is taken, an office being established at the first place affording sufficient shelter. The Austrian authorities lay great stress on the maintenance of a military telegraphic corps, as possessing the triple advantage of constantly increasing the degree of perfection of military telegraphic proceedings—of familiarizing the army to this novel branch of warfare and of obtaining also, under the fire of the enemy, results which could only be exacted from soldiers, and never from civilians.

"The apparatus adopted is the magneto-electric instrument of M. Markus, of Vienna, and is considered to present this double advantage—that the telegraphic communications take very little time in transmission, and that it is itself very portable and does not require any fluid battery.

"The field lines, consisting of gutta-percha covered copper wire, are wound round the drum fixed to a small hand carriage, mounted on two wheels about a yard in diameter, and the frame of which, about five feet long, has a folding leg, upon which to be rested when not in motion. There is also a V-shape guide wheel for keeping the wire central in paying out and winding in. Two men serve the machine. The field telegraph is a magneto-electric apparatus, with alphabetical dial and index handle of familiar construction, and a receiver beside it on the same table, which is formed by the box enclosing the apparatus. This box stands on two folding legs, and a portion of its side opens out horizontally into a seat supported on one folding leg for the operator. One side of this seat is padded, so that when the whole affair is folded up compactly, the porter or soldier may carry it more conveniently by straps

coming over his shoulders. A large umbrella, with long handle, is p vided for sticking into the ground, and forming a sort of tent or shel for the telegraph operator. The poles for elevating the field lines f the ground are carried in horsed wagons, and a sort of large iron c bar is provided for making the holes for their insertion. In general, h a day is considered necessary for setting up a length of two Austi leagues (1½ myriametre, or about 9 miles;) but, under favorable co tions—firm flat ground, and without obstacles, and with strong, trai soldiers—this may be done, it is said, in two hours. The insulators a bell-shaped cups of india-rubber fixed on to iron forked vertical stapl the arms of which are attached to the posts; over the india-rubber i pushed a cap of glass round a ring in which the wire is twisted.'

The Austrians also use a Morse recorder, with clockwork in a comp form. Recording instruments possess advantages over most of t European methods in accuracy and speed, as well as in the more imp ant particular of leaving a record of the message. The greater resp sibility which devolves on the operator when messages are reco tends to care in their transmission, and in military telegraphs, especi this is most important.

The advantages of telegraphy in the field are incalculable; if lines wires are properly laid, the headquarters of any one corps or army c through the network of wires, be placed in rapid communication w any corps at a distance, and thus the greatest of the evils conseq on the separation of two parts of an army, the ignorance of each othe movements, may be avoided.

CHAPTER VII.

SANITARY EQUIPMENTS.

GENEVA CONVENTION—COUNT BREDA'S PANNIERS—BRITISH FIELD MEDICINE-CHEST—WHEELED LITTERS—AMBULANCES.

THE GENEVA CONVENTION.

The sanitary equipments exhibited in 1867 evince a great advance in this philanthropic direction, as compared with any past exhibition. The efforts of the United States Sanitary Commission during the war, and the admirable collection of Dr. Evans, at Paris, render any lengthy notice of these matters unnecessary in this report. The American collection is supplemented, but not excelled, or even equalled, by that exhibited under the auspices of the "International Society for the relief of the Wounded," (*La société de secours aux blessés Militaires des Armée de Terre et de Mer.*) The society originated in suggestions arising from the insufficiency of the military arrangements for the relief of the wounded during the Italian campaign of 1859, and more especially at the battle of Solferino. It is guided in its operations by the principles laid down at an international conference held at Geneva in October, 1863, and by the regulations embodied in the convention of 1864. The conference of 1863 was brought about by a committee of the Société d'Utilité Publique, of Geneva, of which M. Durant, the author of a work entitled "Un Souvenir de Solferino," was the promoter and secretary. It contemplated the formation of national committees to minister to the necessities of wounded soldiers, and to supply and maintain, in time of war, volunteer attendants in aid of the military administration of armies in the field.

The Geneva convention of 1864 has facilitated the working of these committees by establishing the neutrality of field hospitals, equipment, military hospitals in actual use as such, and of the sick and wounded therein. It also provides that the hospital attendants and the personnel employed in the transport of wounded shall, while non-combatant and solely occupied in these duties, participate in the neutrality. Private houses devoted to the accommodation of wounded are also to be respected, and inhabitants who assist the wounded are also to be protected and exonerated from a share of the contributions of war which may be imposed. It was part of the project of the originators of the movement to give the national committees a status during a campaign, independent of the military administration; but this suggestion was likely to be attended with so much inconvenience, and gave rise to so many objections, that it was not noticed in the convention, which only recognizes the neutrality of *military* hospitals and their *personnel*, including, of

course, the volunteer attendants acting under military regulations, and officially recognized by the general officer in command of the army.

All the great European powers have now signed the convention, and the fact that within the last year Austria, and within the last month (July) Russia, have become parties to it, would appear to prove that its principles are consistent with the autocratic military system. The medical regulations of the French army contemplate the assistance of the "Société de secours aux blessés Militaires," in aid of the military administration. Acting on resolutions agreed to at the conference of 1863, national committees of the societies were formed in most of the European states, and those of Prussia, Austria, and Denmark were called upon to practically perform their functions during the campaign of 1865. The good results attending the operations of the Prussian committee during the campaigns of 1865–'66 have gained for it the special patronage of the government, the Queen and Crown Princess taking a personal interest in the subject.

The committee, besides furnishing each army corps with a proportion of volunteer nurses, (more than 600 Prussian ladies acted as such,) procured, with funds raised by voluntary subscriptions, supplies of medical comforts, dressings, &c., to the value of over 2,000,000 of francs. These supplies were periodically despatched, under the personal direction of members of the society, to the different theatres of war, and were there dispensed to wounded and sick soldiers without distinction of nation.

It has been estimated by some that the lives of 40 per cent. of those who have perished on the field of battle in recent wars—many from thirst, hunger, or cold—could have been saved, had it been possible to remove them without delay to places where their wants could have been attended to in safety.

The exhibits of ambulance equipments to accompany an army in the field comprise medicine chests, medical appliances, instruments for medical officers, stretchers, litters, cacolets, ambulance conveyances, &c., of patterns which have been used during the late European and American wars, as well as others shown by the French and English governments, and by manufacturers and persons interested in the subject.[1]

The several articles may be classed as follows:

1. The appliances for dressing wounds on the field of battle, and for the removal of wounded men to the field hospitals, which are usually established immediately in rear of the armies engaged.

2. The equipment of field hospitals or "ambulances," and the conveyances specially constructed for the removal of sick and wounded during the march of a column, or to a fixed hospital or ship.

3. The means for removing sick and wounded from temporary to general hospitals by railway and other land conveyances.

[1] From a valuable paper by Major Leahy, of the British Royal Engineers, we select a description of some of the most interesting exhibits in this class.

COUNT BREDA'S PANNIERS.

Count F. de Breda, one of the secretaries of the "Société de secours," aving carefully studied the equipment in use in the French and other rmies, has also collected, or the consideration of he international committee, a large number of objects of the patterns which ppeared to him to be ost worthy of consideraion.

The panniers in Count reda's collection have een arranged by Mr. rrault. Each is comlete in itself, and besides struments and medines, contains dressings r 250 wounds; the linen, nt, &c., being compressd so as to occupy about alf the space usually quired. The cases are ade of wicker-work and vered with leather. hey are lighter than ooden canteens, and ey afford more security the contents. It is said at one of those exhibd has been thrown from second floor window thout injury to the botes therein. The weight each pannier complete about 90 pounds.

In addition to the paniers, Mr. Arrault has ranged knapsacks to ntain the dressings, &c., ore immediately requird on the field of battle, nd intended to be carried y the hospital attendants of infantry regiments. The knapsacks weigh 6 pounds, and contain dressings for 50 wounded.

British field medicine-chest

BRITISH FIELD MEDICINE-CHEST.

There are several examples of field medicine-chests exhibited, but attention is more especially directed to the two army medicine-panniers exhibited by the British government [see woodcut on page 145] and to the model pannier proposed by Count Breda. The former are baskets covered with hide, and together contain a very complete assortment of medicines and of medical appliances and comforts. The contents are conveniently arranged and securely packed, but they have not been selected with special reference to the requirements of the wounded. Bottles containing poisonous drugs are constructed so as to be readily distinguished from those holding more simple preparations. The panniers will form an operating-table. Their weight is 180 pounds, In connection with them is shown a "Medical Field Companion," a kind of pouch containing a small assortment of medicines and dressings. The weight of this pouch is 11¼ pounds, and is intended to be carried by hospital attendants.

Among the instruments for which merit is claimed is a "coupe-botte," or knife for cutting off the boots of men wounded in the foot.

For the removal of the wounded from the field of battle a great number of contrivances have been proposed and exhibited; but a large proportion are wanting in qualities desirable for the purpose. There is no one example which combines all the conditions necessary to produce a good litter, and which may be stated to be—

1. Simplicity of construction, with means of taking to pieces, so as to facilitate transport and the replacing of damaged parts.

2. Lightness, so far as is consistent with strength; capability of being carried by one man.

3. Means of placing the appliances on wheels, with good springs or suspension, so as to travel over rough ground with easy motion, and thereby facilitate and expedite the removal of wounded.

4. Cheapness and durability.

A stretcher in the British section is exhibited by Mr George Redford the poles of which are in short lengths, and are put together like the joinings of a fishing-rod; but on the whole, the common stretcher, (consisting of two poles and canvas sacking,) used in the British and American armies, appears better adapted to field service.

No litter, however, can be satisfactory which requires two men for the removal of one; and attention is now being directed to wheeled litters by means of which the wounded may be removed, more rapidly and with less fatigue, by half the number of men required for carrying the ordinary stretchers.

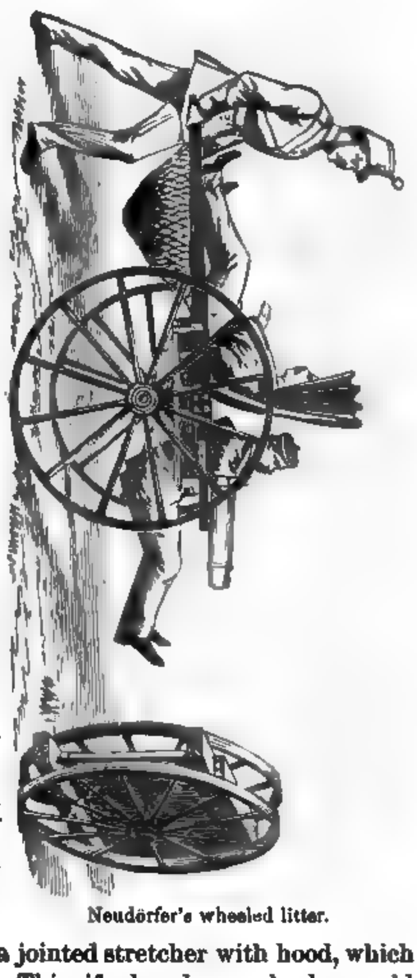
WHEELED LITTERS.

In the Prussian section of the "Société de secours" collection is shown *a wheeled* litter, constructed by Messrs. Neuss, Berlin, which was used

n the campaigns of 1865–'66, and which is made of canvas stretched between two light wooden poles, and placed on springs affixed to an iron axle. The side poles are provided with handles at each end, so that the litter may be drawn, pushed, or lifted. It is provided with a hood to form a protection against rain, and props are attached to the poles by means of which it can be supported in a horizontal position when at rest. Litters of this pattern were used to transport wounded from Düppel to Flensborg (a distance of about 25 miles) in 1865, and it is said that a number were supplied to the French army in Mexico, and were there considered to have advantages over the mule-litters used in the French service. The litters of Messrs. Neuss are light (weight about 110 pounds,) but do not admit of being packed in a small space, and are not so simple in construction as desirable.

A wheeled stretcher will be found in Count Breda's collection, but it has no springs, and admits of many improvements in detail.

Messrs. Fischer & Co. exhibit a wheeled litter which will carry two men—one lying, the other sitting. Conveyances of this kind (see engraving) were proposed by Dr. Neudörfer, an Austrian military surgeon, and were used, it is said, with success in the Schleswig-Holstein campaign of 1865. The example shown appears to be too complicated and expensive for military purposes, and it would not be easy to place a helpless patient in it. It is more economical in labor than Neuss's litter, and if the construction could be simplified might, doubtless, be advantageously used.



Neudörfer's wheeled litter.

The British war department show a jointed stretcher with hood, which can be also used as a chair or bed. This, if placed on wheels, would be a good type of litter.

AMBULANCES.

In ambulance wagons there is a great variety. The French government show two ambulance conveyances now in use experimentally, viz., a two-wheeled cart, weighing 650 pounds, intended to be drawn by

one horse; and a wagon, weighing 2,050 pounds, to be drawn by two horses.

The use of two-wheeled carts is attended with disadvantages, which render it undesirable to adopt them in a model ambulance equipment. In the first place, the motion is most unfavorable for the transport of wounded; and, if the cart were to proceed at a pace quicker than a walk, might be intolerable. Secondly, there would be a great risk of serious accidents to the wounded if the horse were to stumble or the shafts to break.

The new pattern wagon shown by the French government is simply a bad omnibus. It will carry 10 sitting, or two men sitting, and two on stretchers. It does not appear to possess any of the qualities peculiar to a good ambulance conveyance, and which may be stated to be as follows:

1. Very easy motion.
2. Convenient arrangement of bed and seats, with sufficient space and ventilation.
3. Facility for mounting and for inserting the stretchers on which badly-wounded men could be placed.

It is also very desirable that the wagons specially constructed for conveyance of sick should be light, so as not to require, under the ordinary circumstances of a campaign, more than two horses, and that they should admit of being easily turned in a small space.

"Of the special conveyances exhibited," says Major Leahy, "none possess the conditions desirable in ambulance conveyances to a greater degree than those used in America, examples of which are shown in Dr. Evans's collection, and in the shed for the exhibition of American agricultural machinery. These wagons are of the character of light four-wheeled carriers' carts, with extra springs and seats to adapt them to the particular use for which they are intended to be applied. It is said that this class of wagon was adopted after the trial and failure of the heavier description still in use in France and England."

There are occasions when, owing to the absence of roads or tracks for wheeled carriages, it is necessary to employ pack-animals for general army transport, and consequently for the conveyance of wounded. This was the case during the first occupation of Algeria, and it is still necessary to have recourse to pack-transport for supplies sent to the advanced posts in that colony. In reference to this necessity, the French some years since organized a very complete field ambulance, the stores for which, as well as the sick, are carried on mules specially trained and selected for that purpose. The mule train for an expeditionary column of 1,000 men usually consists of 49 animals, each led by a hospital attendant or soldier of the train; of these, 16 are allotted for the conveyance of equipment, and 33 for that of sick.

There are two kinds of mule-litters—the "cacolet," so called from its resemblance to the contrivances used in conveying milk ("caque au

lait") and the litiéres. The former is a kind of arm-chair, one being slung at each side of the pack-saddle, in which the sick or wounded soldier sits upright. The second is a couch similarly carried, in which the man lies down, and is protected from sun or rain by a hood.

Examples of "cacolets" and "litiéres" are exhibited by the French government, by Dr. Evans, and in the collection of "Société de secours;" but this kind of transport is not looked upon as a model except in cases where wheeled transport cannot be available.

The Baden committee of the "Société de secours" exhibits an arrangement for suspending the litters in railroad carriages; and M. Locati, of Turin, submits a plan for fitting up a third-class carriage as a hospital wagon. But the most interesting example of this class of conveyance is a model of the hospital railway cars used by the United States Sanitary Commission, and exhibited by Dr. Evans.

The whole of these articles are being examined in detail by an international committee of the "Société de secours," which has been charged with the task of proposing, with a view to its adoption by the national committees, a model equipment, which shall combine the best points of the patterns exhibited and satisfy the requirements laid down by competent authorities. As this committee includes among its members military medical officers delegated by the governments of the principal powers, it may be expected that military ambulance equipments will be organized on the model which may be eventually approved.

CHAPTER VIII.

FORTIFICATIONS.

FRENCH SECTION—BRITISH SECTION—MARTELLO TOWER—EXPERIMENT CASEMATE—CHALMERS SHIELD—IRON VERSUS GRANITE—EFFECTS O GRANITE—PROTECTION FOR STONE-WORK—THORNEYCROFT BARS—RO PLATE—13½-INCH SHIELD.

FRENCH SECTION.

The Exhibition of 1867, taken as a whole, is very complete relates to war on land and sea, with perhaps the single ex fortifications. Neither in models, nor drawings, can the e branch of the military service compare with the display of heavy ordnance, or iron-clad ships.

The building, or tent, of the French minister of war, cont models evidently illustrating the wars of former days. Th these has a collection of Lilliputian figures, busily engaged in ing a rough-and-ready wooden bridge across a little creek real water. The bridge is being formed with round logs thr the stream, with transverse planking in process of being laid. of a fortified valley, though without any details of constru several models of barrack buildings, are more interesting. Bu great question of fortifications constructed with a view to re destructive power of modern artillery, these throw no light. Phot of Martello towers, and other stone works, in the act of crum pieces under the fire of heavy cannon, are exhibited, but these dently meant to illustrate the power of the guns, not the endu the crumbling structures, and are doubtless exhibited by the o rather than the engineer department.

BRITISH SECTION.

MARTELLO TOWER.

In the British section, photographs of similarly battered wo exhibited, chiefly illustrating the trial of the Armstrong and Whi 70-pounder field-guns. With a view to test the power of the against stone walls, the Armstrong and Whitworth committee o permission to attack a Martello tower constructed on the Susse in 1804, and which mounted one gun. The report of the committe

"The total height of the tower was 31.5 feet; the diameter at th was 46 feet, and that of the top 40 feet. The platform upon whi gun was intended to be mounted was carried by a semicircula turned from a pillar in the centre of the tower, four feet in diam

the exterior wall, there being about five feet in thickness of brickwork between the crown of the arch and the platform of the battery above it.

The situation of the tower with reference to adjoining property was such that conditions of safety precluded the committee from firing at it from any direction but one. All three guns had, therefore, to be in one battery, which was 750 yards distant from the tower, and as a consequence the portions of the tower allotted to each gun as a target were somewhat different, and as the brickwork varied in thickness at almost every foot of its height, the difficulty of obtaining good results for comparison was very much enhanced. The object of the committee not being to destroy the tower, but to obtain good relative penetration for comparison, the firing was commenced with common shell filled with sand.

It appeared that these shells fired from both of the muzzle-loaders had sufficient power to pass through the brickwork where it was seven feet thick, the muzzle-loading Armstrong shell being found unbroken inside, and the Whitworth shell in pieces; the shell from the breech-loader penetrated 4.75 feet into the wall where it was 7.25 feet thick, and 5.6 feet into the wall where it was about 6.4 feet thick, cracking the brickwork inside and knocking away three bricks of one course.

A shot from each gun struck on the solid part of the tower where the brickwork is about 40 feet thick; the hollow-headed shot of the breech-loading Armstrong gun penetrated three feet; the solid shot from the Whitworth gun passed through 7.25 feet of brickwork, having deflected downwards and broken through the crown of the arch; the hollow-headed shot from the muzzle-loading Armstrong gun penetrated 4.75 feet. All the measurements of penetration where the projectiles did not pass through the wall were taken to their bases.

Only one live shell was fired from each gun with results which were capable of comparison, after which the tower became so injured that the amount of damage attributable to each round could not be recorded.

EXPERIMENTAL GRANITE CASEMATE.

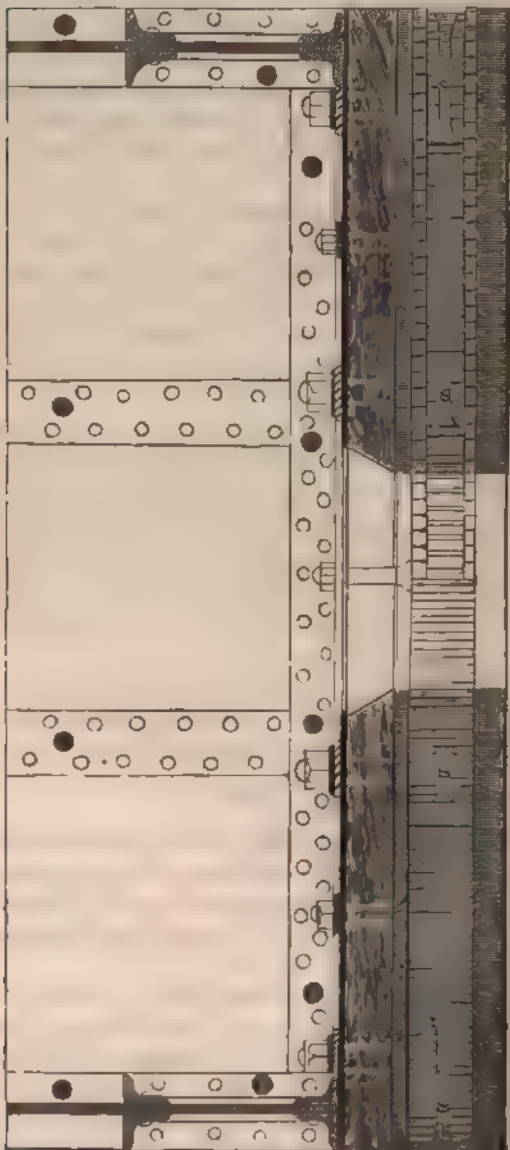
The chief attraction, however, in the British section, connected with fortifications, is the series of photographs which illustrate the trials of the experimental granite casemate at Shoeburyness in 1865. The following illustrated account of this experiment is abridged from Humber's "Record of Modern Engineering:"

"The trial of the granite casemate, represented in Fig. 1, commenced on the 16th November last, and was conducted by the Ordnance Select Committee, assisted by Colonel Jervois, R. E., and Major Inglis, R. E., Superintendent of Works at Shoeburyness. This structure, with its area of about 1,500 feet, presented five distinct features or combinations to the guns: First, the granite work; second, the compound shield A (Fig. 1;) third, the solid plate shield B; fourth, the right or east wing facing, C; fifth, the left wing facing, D. The granite work was com-

posed chiefly of masses of stone of from eight to ten tons weight each. Some of the courses were three feet in thickness, the stones being eight or ten feet in length, and from four to five feet in width. The entire thickness of the granite wall, including a two-feet lining of brickwork, was 14 feet.

CHALMERS SHIELD.

FIG. 2



Chalmers's shield, sectional plan.

"The shield A for the large embrasure, 12' x 8', was made at the Regent's Canal Iron Works. It had a front plate of four inches thick, and a backing of thin iron plates eight inches deep, their outer edges supporting the front plate, and their inner bearing on a second armor-plate of two inches in thickness. This, again, rested upon a cushion of teak timber six and a half inches thick, the whole bearing on a skin of inch iron, and bound together by 22 bolts[1] of three inches diameter, and 16 bolts of two inches, all having shallow square threads. The skin was attached to two struts by double angle-bars 6" by $4\frac{1}{2}$" by $\frac{3}{4}$", and strengthened by six similar bars running at right angles to the struts. A strong girder, 18 inches deep, strengthened the shield across the top of the embrasure. The struts to which the shield is attached rested upon a

[1] These bolts were made of Lowmoor iron, which is too much like steel in its nature and not sufficiently fibrous to stand the vibration caused by the impact of heavy shot.

bottom plate of inch-iron, three and a half feet wide, and through this plate the entire mass was secured to the stonework by 10 bolts of 2¼ inches diameter. The backing bars, where cut to admit the passage of the through bolts, were bound together in bodies by the rivets *a*, Fig. 2. This shield owed its origin to the successful trial of the Chalmers target in April, 1863, and the recommendation of Lord Palmerston, who introduced the inventor to the secretary of state for war. As originally proposed, the principle was the same as the Chalmers target; but at the suggestion of the late iron plate committee, and the engineers of the war department, it was altered to the form represented in the accompanying diagram. For the compound backing or alternate layers of timber and iron of the original design, the present backing of layers, all of thin iron, was substituted, on the ground that it was not advisable to introduce such a perishable material as timber in a permanent work. Half of the shield, therefore, has a backing of plain bars 8″ by 1″, and the other half has bars which match or bind into each other. The latter were suggested by Mr. Chalmers, and their adoption for the entire shield would only have added about £10 to its cost. These alterations, while they still leave a cushion of timber in the very heart of the structure, add greatly to the weight and cost of the shield without improving its powers of resistance. This shield has cost over £1,000, independent of the consideration paid to Mr. Chalmers for the invention and superintending its construction; but a shield of the same size, on the plan originally submitted, (which has been shown to offer greater resistance to shot,) would have cost only about half this amount.

"The western shield B, designed by Major Inglis, R. E., superintendent of works, was manufactured by Messrs. John Brown & Co., of Sheffield. It was simply a solid plate of 13½ inches in thickness, with a port-hole 3 feet by 2 feet 4 inches. It had no fastenings or backing. At top and bottom it was let into the stonework about 6 inches; and in order to keep it up to its work, it was further supported by bars of railway iron imbedded in the stonework, which was fluted to receive them. The right flank of the casemate was protected by the cramped iron facing C, generally termed "the puzzle," because the pieces of iron bind into each other in the manner of certain puzzles made of wood for the amusement of children; and the left flank, D, was protected by 4½-inch armor plates, backed with timber and concrete. The entire cost of this experimental structure, including cost of trial, was about £8,000. The battery to test the structure was placed at 200 yards distance, and consisted of the following guns: 7-inch shunt, throwing a steel shot 115 pounds with 18 pounds charge; 8-inch M. L. gun, throwing a steel shot 150 pounds with 22 pounds charge; 9½-inch M. L. gun, throwing a steel shot 220 pounds with 30 pounds charge; 10-inch M. L. gun, throwing a steel shot 280 pounds with 36 pounds charge.

"The latter charges were increased to 41 pounds when firing at the compound or Chalmers shield A. Against the stonework cast-iron shot only were used.

EFFECTS OF SHOT ON GRANITE.

"It is not necessary here to give a detailed account of the firing. The following graphic account, from an able article on 'the Spithead forts' in *The Saturday Review*, gives a correct summary of the results of the experiments:

"'The experiments were directed to two distinct objects: first, to test the comparative resisting power of the two shields; and secondly, to ascertain how long the huge mass of granite would be able to stand the fire of the formidable battery. In order to approximate more closely to the conditions of a probable attack, the charges of the guns were reduced, so as to give the same striking velocity as if they had been fired at 1,000 yards—a precaution somewhat lenient to the fort, though, as the result proved, not sufficiently so to save it from destruction. The practice on the shields exactly accorded with previous experience. The solid plate was seriously damaged, and a few more shots would have knocked it fairly away.[1] The Chalmers target stood well, as it has always done before; it kept out all the shots, and suffered no great injury beyond the snapping of several of the bolts. The battery was then turned upon the masonry, and though only cast-iron shots were used, the first blow fairly split a huge mass of granite far in the rear of point of impact. Still the shot did not get through, though the ultimate fate of the structure might easily be foreseen. Two rounds from the four-gun battery were then completed. Of the eight shots, one missed altogether; but the other seven struck the granite walls. Upon examination, it was found that a great part of the casemate was a heap of ruins, and that one of the shots had forced a clear passage into the interior of the work. The conclusion is that seven well-directed shots, at a range of 1,000 yards, will suffice to annihilate the projected Spithead forts, and that all the labor and money bestowed upon the works will have been thrown away, unless some better material than granite can be found for their construction. * * It seems pretty clear that the granite gave way, less from the destruction of its face than from the want of elasticity which made the whole mass crack and fall to pieces under the blows to which it was subjected. An iron facing,[2] unless backed by wood and converted into armor strong enough to need no further backing, would do very little to break the shock upon the inner wall of stone, and there is scarcely room to doubt that the first experiment upon it has finally settled the fate of granite as a material for a first-class fort. If it were certain that this conclusion would be accepted without reserve and without delay, there would be nothing to cause alarm in the failure of this first design for our harbor

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[1] The thick-plate shield, which was virtually disposed of at the fourth round, was struck by a total of 765 pounds of metal, propelled by 106 pounds of powder; while the built-up or Chalmers's shield, resisted 2,445 pounds of metal, and 311 pounds of powder.—*Army and Navy Gazette.*

[2] Such as the right and left wings C and D of Fig. 1.

ortresses, but it is sometimes easier to demolish the stoutest material han to batter down a preconceived idea. Perhaps in this particular nstance the failure of the proposed design has been too conspicuous and oo startling to be altogether without effect. It is scarcely conceivable ow that the defences of Portsmouth will be actually built of material o worthless as granite has proved to be; but it is quite possible that the ause of iron *versus* granite for the defence of forts, may be as tedious as he cause of iron *versus* wood was in the construction of ships. In all hese matters the rule seems to be to cling to an old prejudice until it is airly battered to pieces, and we only hope that the moral resistance of the ranite theory may prove as feeble as the physical resistance of the naterial itself.'

"Granite having been thus effectually disposed of as a material for orts, the superstructure of the works at Spithead will probably be chiefly f iron; in which case, reason, science, and all past experiments alike uggest that a large portion of the material should be composed of plates aving their edges opposed to the attacking projectile. An arrangement imilar to that of the Chalmers shield, or perhaps a compromise between : and the 'naval armor,' by the same inventor, referred to in the Record f Modern Engineering, 1863, could doubtless be extended to the entire valls of these forts, with advantage as regards resistance to shot, and conomy of space, if not of cost, as compared with granite."

PROTECTION FOR STONE-WORK.

The "arrangement" suggested in the closing paragraph of the Record rticle had previously been brought forward and submitted to the English and other governments by Mr. Chalmers. It consists mainly of double series of iron plates placed edgewise and running at right angles o each other; the inner series alternating with planks of timber, and he outer composed of H-girders forming cells, which are filled with sphalt. When used as a facing to protect stone works already contructed, it is proposed to use only the front layer and the second plate, vith a cushion timber between them and the stone face; when the system s to be adopted for shields to protect a gun mounted in a stone casenate, or in earthworks, the above method is to be applied in its entirety. The following description from *The London Standard*, of certain experinental structures now being erected at Shoeburyness, will show that his system has been received with favor by the British fortifications' epartment:

"The brick and granite walls are covered with 4½-inch plates about 12 eet long and 3½ feet wide, backed by four girders made of angle-iron and I-plates, concrete about 5 inches thick being run in between the plate nd the girders." The system here described is almost identical with hat of Mr. Chalmers, the main difference being, that the government ngineers use concrete instead of asphalt. The former will doubtless be he cheapest, but whether it will preserve the iron as well as an oleagin-

ous asphalt, or offer an equal resistance to shot, are questions which time and the experiments can best determine. It is doubtful, however,

[illegible] casemate after [illegible] rounds of [illegible] shot, averaging 130 pounds each, with an average charge of [illegible] pounds.

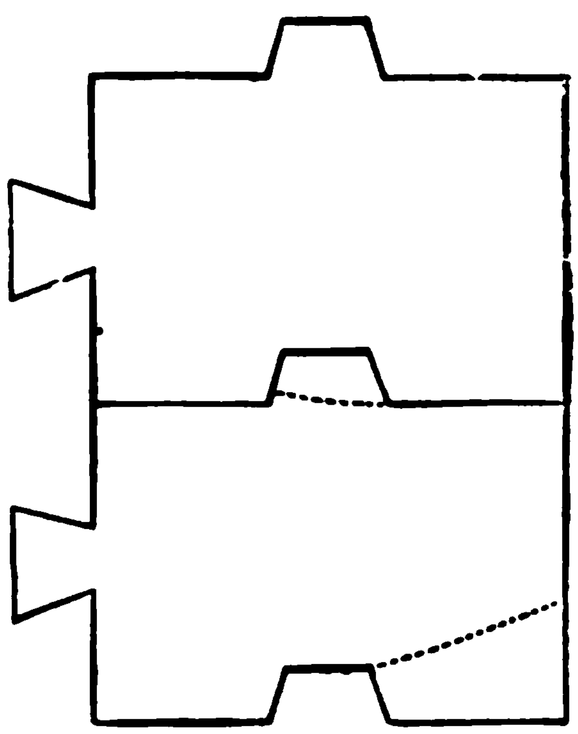
if any arrangement of such girders will give a better resistance to shot than plain plates placed edgewise to the blow. The opinions of engineers throughout Europe seem to be tending in this direction. The original plan of Mr. Chalmers, which consisted chiefly of plain plates of iron placed edgewise to support a thin outer plate, offered a better resistance to shot than a similar weight of material arranged in the ordinary man-

ner. The two experimental committees in England, whose experiments have extended over a period of seven years, agree in recommending this plan—a backing, composed of alternate layers of timber planking and iron plates, placed edgewise to the blow—as the best means of enabling an armor-plate to resist heavy shot.

The British government are now expending over $50,000,000 on fortifications, and their chief engineering difficulty is to protect the sea-face of their works. Before the trial of the granite casemate alluded to, it was intended to build all the sea-walls of granite, with iron shields for the embrasures, but the annexed copy of one of the photographs exhibited, shows at a glance the treacherous nature of the granite. The stone used was of the hardest and toughest nature, and each block was from eight to ten tons in weight. The thickness of the wall or pier, as stated by Humber, was 14 feet, but that was by no means the entire depth of the work; the front facing of granite, 12 feet deep, was supported above the casemates by a structure the total depth of which was not less than 30 feet. The effects here illustrated were produced by 10 rounds each from the guns referred to, with cast-iron shot, and charges so reduced that the range of 200 yards was made equivalent to 1,000 yards.

THORNEYCROFT BARS.

The Russian iron forts at Cronstadt are, doubtless, the most extensive works of this nature yet constructed. Influenced, perhaps, by the conclusions arrived at during the earlier stages of the English experiments, namely, that the resistance of certain plates would be to each other as the squares of their respective thicknesses, the Russians have hitherto used plates and bars of great weight and thickness. One system, known as the "Thorneycroft bars," has been used to some extent at Cronstadt. It consists of bars of iron 15 inches wide and 10 inches thick, which have been rolled with a groove and a tongue, and built up so as to form a wall of iron 15 inches thick with dovetail fastenings in the rear, as illustrated above.



Thorneycroft bars.

So long as structures of this description were subjected to comparatively light tests, which was the case when the Russians adopted them, they were considered to be sufficiently strong and economical. But when they were attacked by projectiles possessing *energy* or *work* equal to 2,000 or 3,000 foot-tons, they gave way at the tongues, (as shown in dotted lines,) and the bar or bars struck invariably opened at the back, thus destroying (almost in the same manner as in the disintegration of granite under impact) the cohesion of the structure.

RUSSIAN 11-INCH PLATE.

In order to get rid of that bugbear of military engineers, a *wood-backing*, the Russian engineers, in another work, had recourse to solid wrought-iron plates of great thickness. One of these plates, about 14 feet long, 4 feet wide, and 11 inches in thickness, manufactured by Messrs. John Brown & Co., of Sheffield, was sent to Shoeburyness to be tried. It was attached at the ends to a strong framing in order that it might be fired at without backing, the belief at the time being that the plate would be of sufficient strength unbacked. A 13¼-inch gun was laid at the centre of the plate, loaded with a solid spherical steel shot of 360 pounds weight, and a charge of 70 pounds of powder. The shot, with a *vis viva*[1] of about 3,750 foot-tons, struck the plate fair in the centre, when the calculation, that the plate would resist penetration, was fully verified. But another result not calculated on followed. The plate, though it arrested the progress of this single shot, was split from end to end by the blow, both halves being torn from their fastenings and one of them thrown several yards away from the other, as if it had been a chip of timber, leaving exposed the work they were intended to protect. Had this target consisted of eleven superimposed inch-plates, it would doubtless have been more easily penetrated, *(if unbacked,)* but it could not thus have been so easily torn away from its fastenings. There seems to be little doubt that laminated plates supported by a compound backing, like that of Mr. Chalmers, would give a very effective protection to stone-works, and at much less cost than any system which requires heavy, and consequently expensive, forgings. Assuming the eleven-inch solid plate, upon a backing of fifteen inches of timber, to be a sufficient protection against the heaviest ordnance in existence, let us see what probable protection (and at what comparative cost) could be obtained by a like weight of inch-plates disposed in the manner adopted in our iron-clads and supported by the system of backing exhibited by Mr. Chalmers. These structures [see woodcut] are of the same weight and depth of materials, and their respective costs, to cover an area of 10,000 superficial feet, would be as follows:

[1] The *vis viva* of a body in motion is the whole mechanical effect which it will produce in being brought to a state of rest, without regard to the time occupied, and it varies as the weight of the body multiplied by the square of its velocity. This mechanical effect, or "work," accumulated in the moving body is represented by the weight which it is capable of raising one foot high, and is equal to the weight of the moving body multiplied by the square of its velocity, and divided by twice the force of gravity, or

$$\frac{W v^2}{2 g}$$

Thus if a shot of 165 pounds weight be moving with a velocity of 1,470 feet per second, the "work" accumulated in it will be represented by

$$\frac{165 \times 1470 \times 1470}{2 \times 32.1908}$$

which is equal to 5,538,049 pounds, or 2,472 tons. That is to say, the force stored up in the shot is capable of lifting a weight of 2,472 tons one foot high.—*Captain Noble.*

ıch would require 2,200 tons (of 2,000 pounds per ton) of iron. The ates of Fig. 1 would cost at least $200 per ton, or a total of $440,000 for ıe 10,000 feet; while those of Fig. 2 could be procured for $60, or a total $132,000. Though the latter would cost for work, in putting the

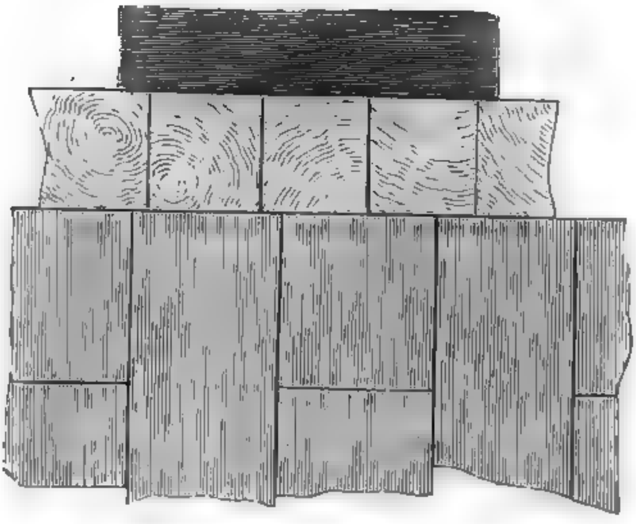


Fig. 1.

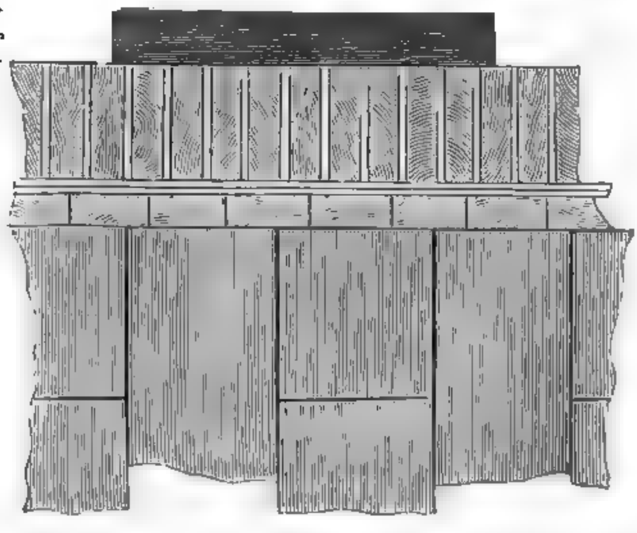


Fig. 2.

Scale ¼ inch to foot.
Stone forts with iron armor.

N. B.—The armor of Fig. 1 costs three times as much as Fig. 2, or for the same cost the latter could have twenty-eight inches of plating instead of eleven.

ıcking together, say $20,000 more than the former, it would still be little ore than one-third of the cost of the thick-plate structure. The solid ates might possibly offer a better resistance to shot, though even that doubtful, but the other would not be so easily torn from its fastenings. ıe question of laminated *versus* solid plates has not yet been fully and ırly tested. The views of engineers and scientific men generally are

now undergoing a change on this subject, and many are of opinion that thick plating with its consequent treacherous fastenings may yet be superseded, both on land and sea, by superimposed layers of iron supported by a backing of thin plates placed edgewise to the blow.

13½-INCH SHIELD.

We have seen what became of the eleven-inch plate made for Russia, and the trial of the 13½-inch casemate shield has also been noticed, but a few more particulars relating to the latter experiment will show that those engineers who are looking for protection to a combination of light plates, are more likely to reach their object at a reasonable cost than those who pin their faith to mere thickness of iron. The following cut gives a fair idea of the 13½-inch shield in its present condition as shown in the Exhibition. It was made to protect a gun mounted in the aforesaid granite casemate. It is 8 by 6 feet, and has an embrasure, or port-hole, (3 feet 6 inches in height and 2 feet 4 inches wide,) rounded off at the corners, and slightly bevelled on the inside to admit of training the gun.

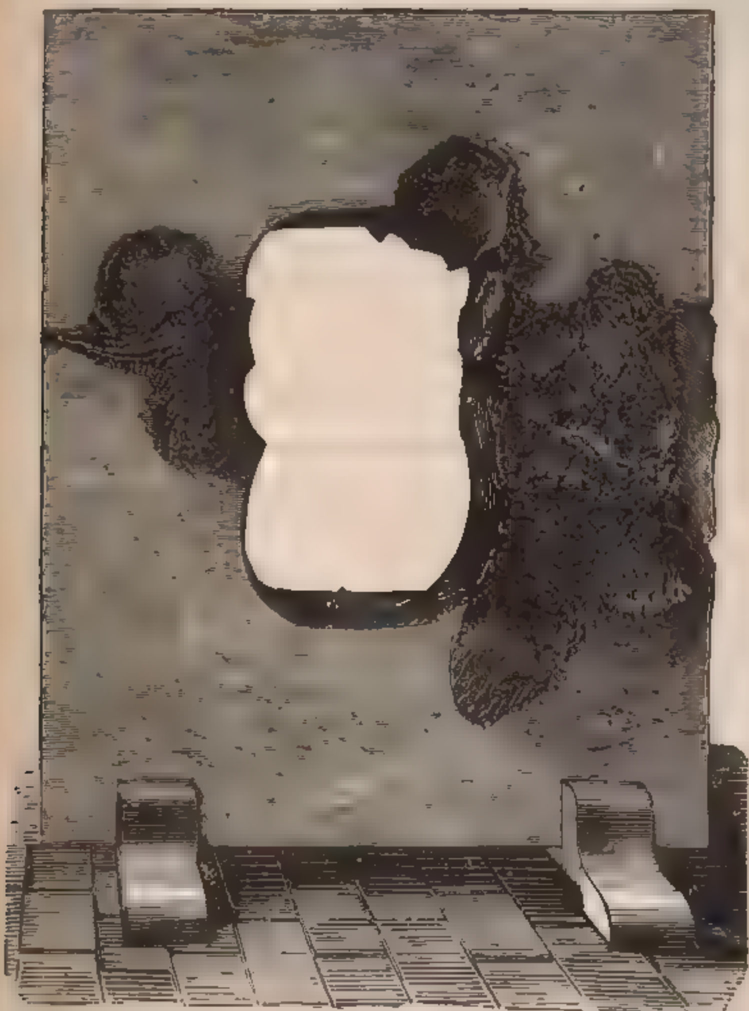
The single shot fired at the Russian eleven-inch plate struck with a force equal to 3,750 foot-tons, English, (equal to 8,400,000 foot-pounds,) but the most trying shot fired at the 13½-inch shield did not exert a power of more than 3,200 foot-tons, while several of the eight shots fired were under 2,000 foot-tons. The following table gives the particulars of the firing. Range 200 yards:

Number of rounds	Gun.	Usual battering charge.	Charge employed.	Weight of shot.	Work, foot-tons.
	Inch.	*Lbs.*	*Lbs.*	*Lbs.*	
1	7	22	18	*115	1,411
2	8	30	22	*150	1,676
3	8	30	22	*150	1,676
4	9½	45	30½	*222	2,662
5	10	50	36	*285	3,154
6	10	50	36	*285	3,154
7	9½	45	39½	*221	‡3,000
8	9½	45	30½	†217	‡2,500

* Steel. † Cast iron. ‡ About.

The work in round No. 8 (cast-iron shot) was expended chiefly on the shot itself, while rounds 1, 2, and 3 served only to make up the total of metal fired, without doing much damage to the shield. The actual work done, therefore, was the result of rounds 4, 5, 6, and 7. Of these No. 6 struck on the lower right-hand corner, the strongest part of the shield, and No. 7 struck on the upper corner, and glanced into the embrasure, expending its work on the gun and carriage inside. There remain then only two rounds (4 and 5) which in reality did the damage shown in the woodcut. One cracked the right-hand side, and the other the left, clean through, so that the shield is now held together by dowels of three inches

diameter. There can be little doubt that a single shot like that fired the Russian plate, with its stored up work of 3,700 foot tons, would



13½-inch shield

iking where rounds 4 or 5 struck) have sent the shield broken in two to the casemate. What, then, would be the effect, on such a shield, of steel shot from the 15-inch Rodman with 100 pounds of powder, and a *viva* of over 7,000 foot tons?

We have dwelt on these experiments longer than we originally intended; ll, if these facts and observations be instrumental in preventing the penditure of the public money on expensive and unreliable works, we all not regret that so much time and space have been occupied in dissing them.

CHAPTER IX.

IRON-CLAD SHIPS.

THE EUROPEAN IRON-CLAD—LA GLOIRE ARMOR—WARRIOR AND MINOTAUR ARMOR—BELLEROPHON ARMOR—SMALL-PLATE TARGET—BOX-BATTERY IRON-CLADS—FRENCH IRON-CLADS—NUMANCIA—GOUIN'S PROPOSED ARMOR—TORPEDOES AND SUB-AQUEOUS PROJECTILES—BELLEROPHON 6-INCH PLATE—15-INCH PLATE—FRENCH MARINE ENGINES—BRITISH NAVAL DISPLAY—AMAZON AND OSPREY—WARRIOR CLASS, SAILING QUALITIES—ACHILLES, SAILING QUALITIES—STRENGTH OF WARRIOR ARMOR—MINOTAUR CLASS—BELLEROPHON, SAILING QUALITIES—BOX-BATTERY, ANGLES OF TRAINING—MONARCH AND CAPTAIN—HERCULES—ROLLING DIAGRAM—ADMIRAL YELVERTON'S REPORT—LORD WARDEN CLASS, VULNERABILITY—CONFEDERATE RAMS—BRAZIL GUNBOAT—MITCHELL'S MONITORS—HALSTED'S TURRET-SHIPS.

THE EUROPEAN IRON-CLAD.

The illustrations and models of iron-clad ships of war in the Paris Exhibition are, as a whole, more varied, comprehensive, and interesting, than any other class of war material exhibited. Nevertheless, a cursory glance will suffice to show that the European iron-clad is still an embryotic production, indefinite as to its mission, or the means by which that mission is to be accomplished. Whether it is to be a ram, crushing its antagonist by its own momentum, or a huge gun-carriage, depending on one or two large cannon for its offensive qualities, has not yet been determined. A great number of the models exhibited are intended to combine both of these qualities. In others, again, such as the French Gloire and the British Warrior, the conventional ship-of-war type, with its broadside of many guns, is still adhered to. The monitor—pure and simple—does not seem to be in favor with European naval constructors, though the turret principle, especially in projects, is well represented. We shall endeavor to notice the respective exhibits of each nation, more particularly such features in them as tend to illustrate the progress making in iron-clad construction in Europe, and the direction in which the science of naval warfare is tending.

Before, however, adverting to the question in the shape in which it presents itself in the Exhibition, it will be well (and may lead to a better understanding of the subject) to notice briefly the several stages through which the construction of European iron-clads has passed. British writers generally ascribe the suggestion of iron armor to citizens of the United States,[1] though necessity only forced it into practical use both in Europe and America. The *Scientific Review*, of London, in an article on armor, says:

"It was the Crimean war that gave the first impulse to a more efficacious armament of the infantry, the fire-arms of which disagreed in too

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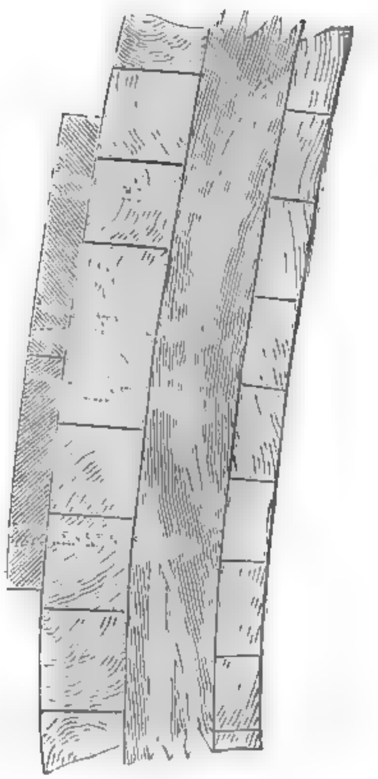
[1] It is said the Dunderberg was designed in 1853.

great a measure with the present exigencies of range and accuracy. It was the gigantic scale of the Russian defences that suggested the first practical essay of heavy rifled artillery, which step, coupled with the loss smooth-bore artillery had suffered through the extensive introduction of superior fire-arms, rapidly led the way to the application of rifling to field, siege, and, lastly, even to naval guns. And again, it was pending this war that the attempt was made of defying the murderous power of horizontal shell-firing, by resorting to the scheme, apparently impracticable, of applying wrought-iron slabs of armor to the sides of floating structures called batteries. The idea was not novel. Mr. Stevens, of the United States, first conceived the plan of covering wooden batteries, somewhat similar to D'Arcon's, with inclined plates of sufficient thickness to resist both solid shot and shell. Ten years later Paixhan, after he had invented his destructive hollow-shot guns, proposed to neutralize their formidable character by plating batteries with thick wrought-iron armor; thus acting very much like, though in the reverse way to, the celebrated Vauban, who, after having fortified a considerable number of towns, invented the ricochet fire of the siege batteries, when called upon to overcome the resistance offered by his own tracings and defensive combinations."

LA GLOIRE.

Scale ½ inch to foot.



La Gloire armor.

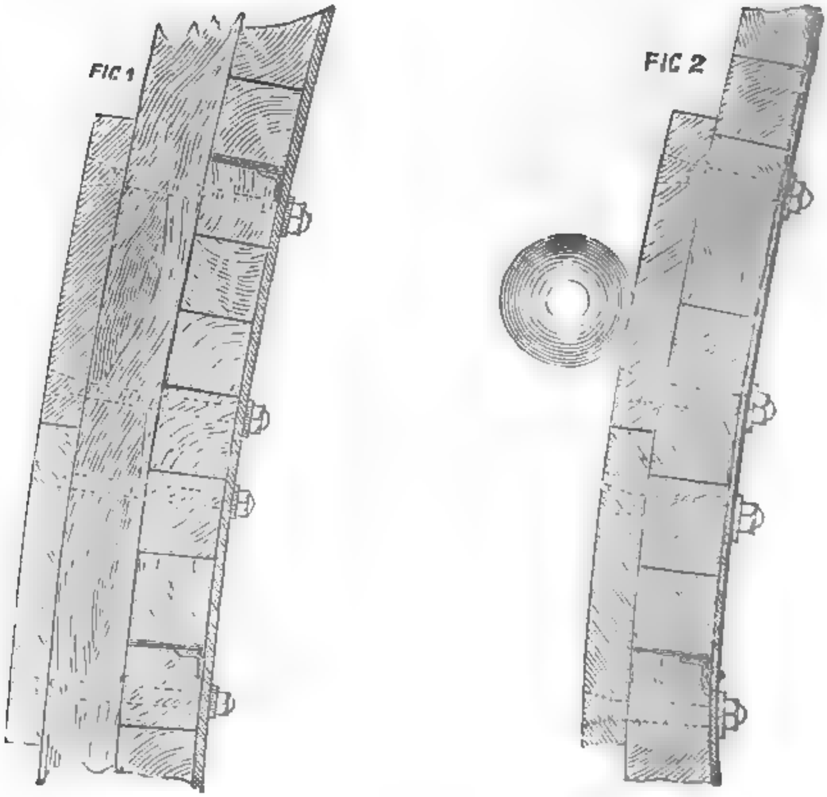
The chief object of iron armor for ships of war was to keep out shell by breaking them up on impact. The destruction of the Turkish fleet by a couple of broadsides in the roadstead of Sinope, taken in connection with the impunity with which the French batteries attacked the Kinburn forts, proved the value of iron plating so far as to induce the governments of France and England to adopt the new method of naval construction. The French, discarding the idea of inclined sides like those of the Dunderberg, plated a wooden ship of the ordinary frigate type with small plates, of 4¾ inches in thickness. These plates are comparatively easily made, put on, or removed, and are attached to the ship's side by a plentiful supply of wood-screws, screwed into the timber backing. The Gloire, in short, has a timber scantling, similar to that of any line-of-battle ship, covered by a 4¾-inch plate. Of this armor the annexed wood-cut is a vertical *section, without* details, and with the exception of an

increase of from 1½ inch to 3 inches to the thickness of the plate, French armor is the same still. This increased thickness of plate, however, has been obtained by sacrificing the protection of a large portion of the ship's surface, a feature of European iron-clads that will demand some attention further on.

WARIOR AND MINOTAUR.

England followed pretty closely the lead of France in regard to the thickness of the plate and backing, but her Warrior was an iron, not a wooden ship. Fig. 1 of the following sketch is a vertical section of the Warrior target, without details of fastenings, &c. Though this target

Scale ¼ inch to foot.



Warrior armor. Minotaur armor.

gave very satisfactory results, when attacked by the 68-pounder smooth-bore and the 110 pounder Armstrong gun, it was evident that improved ordnance was coming into general use that would soon render the Warrior armor useless. Notwithstanding this acknowledged inefficiency of the Warrior type, the next step taken by the British admiralty was a retrograde step. In the three largest ships of the navy (the largest and *most* costly ships of war ever built) the timber backing of 18 inches was

reduced to 9 inches, and the iron plate increased from 4½ inches to 5½ inches in thickness, thus reducing the entire thickness of ship's side to 15.125 inches. A target representing the armor of these three ships, (the Minotaur, Agincourt, and Northumberland,) of which Fig. 2 is a sketch, was tried at Shoeburyness, and such shot as failed to penetrate the Warrior target "swept clean through that of the Minotaur, carrying plate, backing, skin, frame, and all before it." There is little or no doubt that a shot from the 15-inch Rodman, (such as represented in Fig. 2, p. 164,) with a 60-pound charge, would pass in at one side and out at the other of such ships as the Minotaur and her consorts. The severe strictures of the London press doubtless helped to prevent the construction of any more ships of this class. *The Times*, referring to the trial of the Minotaur target, said: "It almost crumpled up under fire." But though these ships were not commenced when this trial took place, the leading journal, years afterwards, lamented that "the very reverse of what the experiments pointed out had been persisted in." "They built these ships," says *The Saturday Review*, "not in accordance with, but in the teeth of the experiments." *The Mechanics' Magazine* said, "So far as effective service is concerned, they might as well be classed with the three-deckers now rotting at their anchors at Portsmouth and Sheerness, for the ordnance with which the great maritime powers are arming their ships can destroy our Minotaurs as easily as the Russian guns destroyed the Turkish fleet at Sinope." Nor were there wanting other and more authoritative warnings given in ample time to prevent so great a blunder. The Iron-plate Committee, under whose auspices these experiments took place, reported that "the reduction of the timber backing is a source of weakness for which the extra thickness of the armor-plate is not sufficient compensation," for the Minotaur target was in a far worse condition after receiving only 740 pounds weight of shot, than the Warrior target after receiving 3,980 pounds, at similar velocities.

Thus, by following this retrograde step of the British naval constructors, we have seen that in naval armor, as in armor for land works, mere thickness of iron plating will not give effective protection, and we come back to the point from which we started, proposing the question, Where then is protection to be looked for? A glance at the next stage will probably furnish a tolerably satisfactory answer. We have seen the French settle down satisfied with the essentially unscientific method of screwing plates of various thicknesses to the sides of wooden vessels. With the exception of a few rams and floating batteries for coast defence, these characteristics describe the French navy still. Some naval powers, such as Spain, Italy, and Austria, have, to a considerable extent, followed the French, while Prussia, Denmark, Holland and Turkey, seem to follow the wake of England. Hence, the question of an efficient armor for ships of war was a wide question, interesting to and affecting many nations.

"A problem of this nature," says *The London Telegraph*, "could not fail, as a general rule, to absorb the attention of engineers, and promote

emulation amongst them; but in the present case it had the exceptional qualifications of exciting an intense feeling of interest in the public at large, of holding out unusual promises, and, lastly, of opening a great field of ambition. As was to be expected in a case like this, men of all classes came forward, and, of course, all sorts of ideas were brought to the surface, some feasible, others absurd. Of the former, many were characterized by an endeavor to attain resistance at the expense of the backing, the plate alone being looked upon as the element of impenetrability. Many of our most eminent engineers adhered to this plan, forgetting, strangely enough, the mechanical principles which cause the blacksmith to give the anvil an elastic foundation of wood in solid blocks—which enable the cobbler to hammer leather on his knees, by using a thick and heavy stone as a cushion—and permit railroads successfully to bear enormous weights.

"Other plans, on the contrary, laid great stress on the part played by the backing; in fact, they took a line diametrically opposite to that followed by the former, their originators having evidently understood the lesson conveyed by the comparative superiority of the Warrior with regard to a system based on the use of thicker plates and thinner backing. They may not have seen what constituted the secret of impenetrability, but it was apparent to them that, by improving the rigidity, and at the same time the elasticity of the backing, they would increase the resistance to compression, and proportionately diminish the plate's tendency to buckle and give way before the shot. One would have thought these principles plausible enough to merit fair consideration, or novel enough to excite official curiosity. Such, however, was not the case in any way; the Admiralty being either unable to appreciate the scientific features, or determined never to depart from their own favorite ideas, right or wrong. Be this as it may, we find that amongst the persons who sided with the backing a certain Mr. Chalmers distinguished himself especially for his perseverance in bringing the question into notice, and at the same time for his faith in the practicability of his invention."

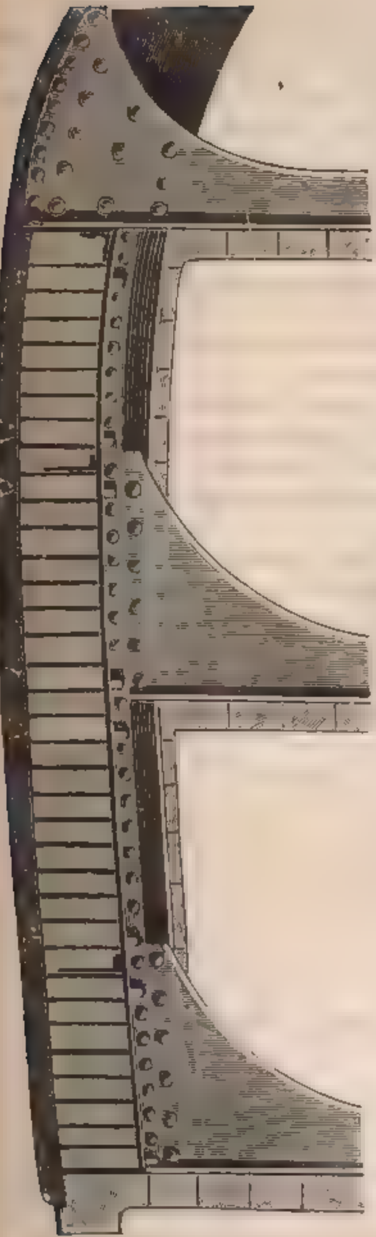
CHALMERS ARMOR.

This invention, and the target in which it was tried at Shoeburyness,[1] has perhaps attracted more attention in Europe than any other contriv-

[1] A further trial of this invention was made this year at Vincennes, some idea of which may be gleaned from the following extracts from *The Pall Mall Gazette* and *The Standard*. The former says:

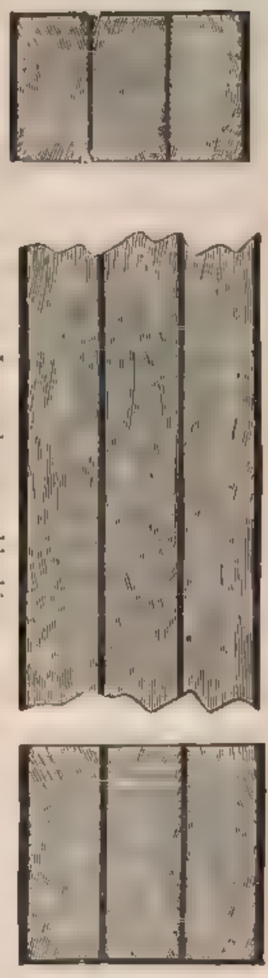
"Some experiments as to the strength of targets were, we hear, made yesterday at Vincennes, when the 9-inch 12-ton Armstrong gun failed to penetrate a 5½-inch plate of iron backed on the Chalmers system. Half-a-dozen rounds were fired at 25 yards distance, and at the close of the experiments it was found that three of the shot were lying in front of the target, and three sticking in the backing. The full service charge of 43 pounds of powder was employed, and the steel shot had the ogival head recommended by Major Palliser. It is only about ten days ago that the 7-inch Armstrong with a 15 pounds charge sent the Palliser shot through plates seven inches thick at Shoeburyness. The plates were without backing, and were composed of two 2-inch layers of wrought-iron enclosing a 3-inch layer of ...

"These experiments seem to deserve attentive consideration. Strict comparison with those



Scale, ¼ inch to 1 foot.

The Chalmers system of armor.



Improved compound backing.

Longitudinal section. Scale, 1 inch to 1 foot.

Cross section.

ance for keeping shot and shell out of ships of war. It is illustrated in the Exhibition by models and drawings. The woodcut on p. 167 will illustrate the principles embodied in this invention. Fig. 1 represents this system as tried in the Chalmers target, which had a 3¾-inch armor plate, a compound backing, a second plate, and a cushion with stringers (running at right angles to the ship's frames) between the second plate and skin, the stringers being riveted to the latter. The inventor suggests that his system of compound backing would materially aid a ship in resisting the blow of a ram, for the backing could, as represented, be carried below the armor-plates, and, by thus presenting a series of well-supported ribs of iron on edge, it would distribute the blow of a ram over a much greater surface.

Fig. 1 represents the compound backing on a large scale. The weight of materials represented in the woodcut, Fig. 1, if for ships of the Warrior or Minotaur class, would be, in the three systems, distributed in about the following proportions: Chalmers's plan, 46 per cent. in the structure, and 54 in the armor-plate; Warrior plan, 32 per cent. in the structure, and 68 in the armor-plate; Minotaur plan, 26 per cent. in the structure, and 74 in the armor-plate.

As the trial of the Chalmers target has influenced the construction of British iron-clads, and consequently those of other nations who follow her lead, it will be both useful and interesting to consider for a moment this experiment and its results. The target was furnished by the inventor free of cost, on condition that if it resisted better than the Warrior and other targets previously tested, he should be paid his expenses, not to exceed £4,650 ($8,250.) The practical results of the trial, in a word, were non-penetration by the guns and projectiles hitherto used; the absence of the usual buckling of the armor-plates; and a practical security of the fastenings by the use of a shallow thread in the armor-plate bolts. One of the targets, which preceded this by only a few months, had 21 out of 23 bolts on one side of the porthole broken by nine rounds, whilst the Chalmers target had no bolt broken up to the 24th round, when one snapped under a salvo of five shots, from two 68-pounder and

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recently made against combined steel-and-iron plates at Shoeburyness is hardly possible, because the plates there were unsupported, and the effects of the Palliser missiles upon them was more of a simple punching nature. Still when we regard the fact that in our experiments a 7-inch gun was used against 7-inch plates, and just penetrated, when propelled with 15 pounds of powder, we must accord some very considerable value to Mr. Chalmers's backing when, with its assistance, a 5½-inch plate can be made to keep out the larger and heavier shot from a 9-inch gun. We know that, in these last Vincennes trials, the effect of two or three of the stringers in the backing brought into resisting action simultaneously by the impact of the missile prevented penetration, even with full charge. This would seem to indicate that the number of iron laminæ in the backing might be increased and the thickness of the wood planking diminished, or, in other words, that the more frequent alternations of wood and iron planking would be beneficial to resistance offered by the Chalmers target. These particulars would also seem to extend the proofs of the value of Mr. Chalmers's system."—*Standard.*

three 110-pounder guns. *The Times* said it was "the only target that had fulfilled all the requirements of strength, so needed and so long sought for;" and *The Daily Telegraph* stated that "it was proved—proved beyond a doubt by the issue of the Chalmers target—that the resisting power of the armor was far more dependent on the nature of the backing, than on the thickness of the plate." Before these opinions appeared, however, the secretary of the admiralty stated in Parliament, referring to this trial, that "if this experiment be favorably reported on, it will lead to important alterations in the construction of our iron-plated ships." The iron-plate committee, in summing up their report,[1] said: "No other target designed for naval purposes has resisted a similar weight of shot with so little injury;" and the lords of the admiralty wrote to the inventor saying that "the suitability of your plan to wooden as well as to iron ships has been, and still is, under consideration." Now it will be necessary to a due appreciation of the subject to see whither this "consideration" tended. *The Scientific Review* says: "The Chalmers target showed the value of stiffness and elasticity, and led the way, first to the Bellerophon armor, and then to the Lord Warden;" and Mr. Chalmers himself contends, "that the result of this consideration has been the adoption and construction of two new classes of armored frigates, the Bellerophon class iron ships, and the Lord Warden class wooden ships." This is not only the opinion of the inventor and the press, but Sir John Hay, the chairman of the iron-plate committee stated in Parliament, "that one of the most essential and valuable principles of the Chalmers target had been embodied in the Bellerophon. That was his opinion, and also that of the iron-plate committee."

Having thus traced the history of British iron-clad armor to the intro-

[1] The following, from *The Standard*, are extracts from the report of the iron-plate committee: "The target was fired at with steel and cast-iron projectiles from the following guns: 68-pounder smooth-bore, with cast-iron shot and shell, 16-pound charge; 110-pounder Armstrong, with cast-iron shot and shell, 12-pound and 14-pound charges; 300-pounder Armstrong, with cast-iron spherical shot and 50-pound charge, and lastly, with the steel solid shot of 301 pounds from the 300-pounder Armstrong with 45-pound charge. * * * The experiment proved that this system of backing affords great support to the armor-plates, and prevents their distortion from buckling. It is also of considerable advantage in adding strength and resisting power to the structure. * * * No other target designed for naval purposes has resisted a similar weight of shot with so little injury. * * * * The backing proved much more substantial than the backing of wood without the interposition of the iron plates, which seem to prevent the crushing of the wood, and the spreading of the fracture to the contiguous portions of the backing. It would also probably tend to prevent ignition from the explosion of shell, and evidently affords great support to the armor-plate, as was shown by the furrows on the rear of the plates.

"The Chalmers target, though of much smaller area than the Lord Warden target, suffered much less from the blow of the 10-5 steel projectile with 45-pound charge; the area of destruction in the Lord Warden target being 8 feet by 4 feet, whereas the area of destruction in the Chalmers was 2 feet by 1¼ feet."

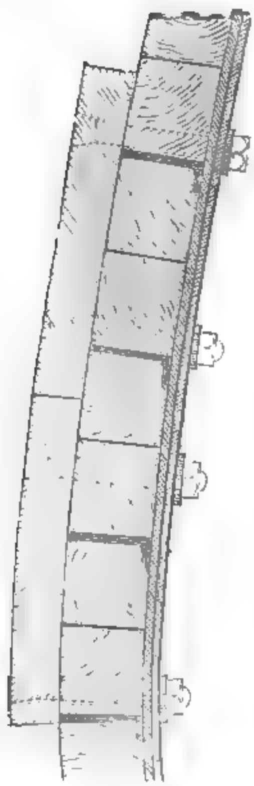
Area injured in the Lord Warden target 32 feet; area injured in the Chalmers target 3 feet. Weight of the Lord Warden target, per foot, 482.9 pounds; weight of the Chalmers target, per foot, 371.5 pounds.

duction of horizontal plates, or stringers, between the timbers of the backing, it is desirable to see if the principle of a compound backing has been fairly carried out.

BELLEROPHON ARMOR.

Our engraving of the armor of Bellerophon will show that the adoption of Mr. Chalmers's plan has not been so complete as the above opinions would lead us to suppose. The fact that this system was devised at the same time that Mr. Chalmers's plan was under consideration, and by the very parties who were considering it, leaves little doubt as to whence the new features were derived, but it is open to question whether much real advantage has been derived from the *partial* adoption of a plan that, as a *whole*, seems founded on sound principles. An able writer in the Daily Telegraph on this point observes:

Scale ½ inch to foot.



Bellerophon armor.

"The principal features of the Chalmers plan were evidently embodied in this. If the designers of the Bellerophon had mastered the real secret of the resistance attained in the Chalmers target they might easily have improved on the latter without going beyond the intended weight; but then the similarity between the original and the derived targets would necessarily have been more marked; so, to avoid this, some slight alterations were introduced, to the prejudice, rather than to the advantage, of defensive qualities."

The weakness of the armor of the Bellerophon (said to be the strongest British iron-clad afloat) is strikingly illustrated by one of the plates of the Bellerophon target, shown in the Exhibition, and which we will refer to more fully when we come to speak of the ship models exhibited in the marine section. Suffice it at present to say, that this six-inch plate has been completely riddled by a seven-inch 6½-ton gun, with 115 pounds shot and 22 pounds charges. The plate of course is exhibited to show the penetrating power of the gun and projectiles.

Before closing this cursory sketch of iron armor, and taking up the question in detail, as illustrated in the English and other European models exhibited in Paris, we venture to suggest that the thin plates of iron interspersed in the backing would, if placed *closer together, even than* in the Chalmers target, have given better results than when placed

further apart, as in the Bellerophon, and in the target lately tested at Vincennes. Mr. Chalmers, as we have seen, proposes to continue his backing considerably below the water-line, with a view to enable ships of war to resist the blow of a ram, and suggests that thin laminated plates of iron on his backing would offer an equal, if not a better, resistance to shot, than a similar weight of solid plating on a backing of timber. Laminated plates with this, or indeed any backing, have not, to our knowledge, been tested on the Continent; and in England the influence of the armor-plate manufacturers has been sufficient to prevent any trials likely to endanger their craft. The question, however, is one well worthy of attention, and if it be found that a judicious use of thin plates of iron, or steel, among the backing timbers of an iron-clad, will enable laminated plates, or even thinner solid plates, to resist shot as well as the same weight of iron on a backing of timber, a great point will be gained, and a great saving effected in the construction of iron-clad ships.

SMALL-PLATE TARGET.

La Gloire, whatever may be her qualities as a ship of war, is in one sense the *first* iron-clad in Europe, and therefore her failings, be they few or many, ought to be charitably considered. We have seen that she is a wooden frigate wholly covered, from her upper deck to six feet below her load-water line, with iron slabs 4¾ inches in thickness. It would have been a pleasing task to have examined this and other French ships minutely, but the lock and key of the glass case in which the models are exhibited forbid a close inspection, and sketching is prohibited. Nor are there sections shown, and dimensions given, as in the case of England and other countries. We have already given a sketch of the scantling and armor of La Gloire, and no thickness of plate has been more tested in England than 4½ inches, the thickness adopted in the Warrior targets, of which upwards of a dozen have been tested. However, a target constructed on the French system, and called the "small plate target," was tried at Shoeburyness, and the experiments against this target will give a tolerably fair idea of the resistance of ships of La Gloire and the Flandre class. One half of the target was covered with 4¾-inch plates to resemble the Gloire armor, and the other half with 6-inch plates (5″.9,) which represents the armor of a large proportion of the French navy. See the following table:

Table of rounds fired at the "small-plate target," at Shoeburyness, one-half of which consisting of 4½-inch plates represented the French iron-clad La Gloire, and the other half of 6-inch plates represented the Solferino, Magenta, &c. The powder used was L. G. rifle powder, and the range was 200 yards.

Round.	Plate.	Gun.	Charge.	Projectile. Nature.	Projectile. Weight.	Striking velocity.	Work in foot-tons.	Remarks.
No.	*Inch.*		*Lbs.*		*Lbs.*			
1	6	68-pounder, smooth bore	16	Spherical cast-iron	66	1,389	878	Indent about 2.2 inches
2	4½	......do......	16	Spherical steel	73	1,371	962	Indent 3.9 inches, cracked round bottom.
3	6	7 inch B. L., 81 cwt	12	Cylindrical steel	110	1,090	914	Indent 2.8 inches, plate cracked at back.
4	4½	.... do	12	.... do	110	1,090	914	Penetrated and stuck in plate.
5	4½	9 inch 12 ton M. L	30	Cylindrical steel, chilled	269	1,292	2,682	Target completely penetrated, massive knee driven 8 feet to rear, shot broke up.
6	6	.... do ...	25	Spherical steel	113	1,452	1,650	Indent in target 10 inches.
7	6	.....do ..	30	Cylindrical steel	292	1,310	2,642	Target completely penetrated, rear supports (16 inches square) smashed, shot struck "Scott Russell target" behind.
8	4½	.....do...	44	Cylindrical cast iron	256	1,375	3,384	Target penetrated, massive knee driven 16 feet to the rear, shot broken up.
9	6	10.5 inch M. L	35	Cylindrical steel	297	1,105	2,514	Target completely penetrated.
10	4½	.. ..do.....	22½	Spherical steel	166	1,290	1,637	Through target, which was, however, badly shaken by previous rounds.

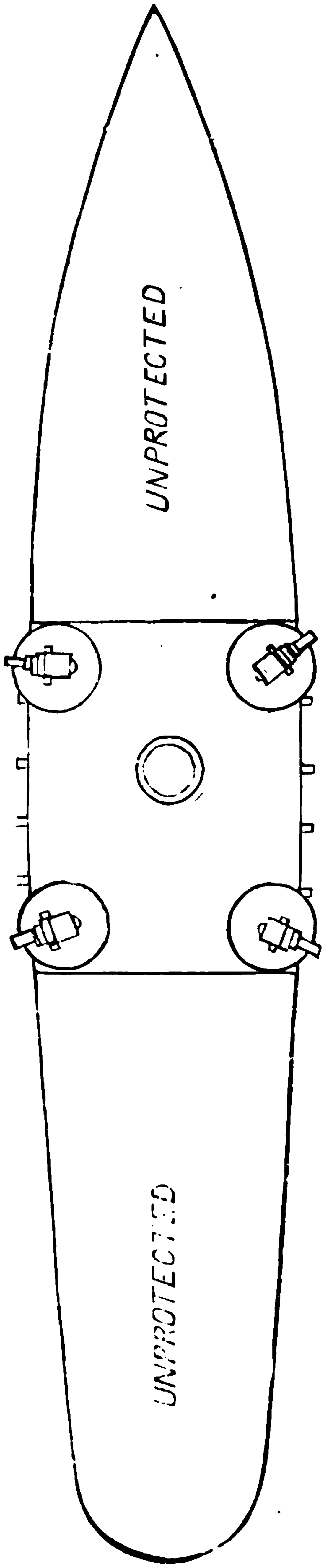
. few more rounds were fired, with like results. The most interesting nd in the above table is doubtless the 10th. Here a spherical steel t of 166 pounds weight, propelled by 22½ pounds of powder, attains riking velocity at 200 yards of 1,290 feet per second, and carries with ,657 foot-tons of work. It passes clean through the target, which, ugh "badly shaken by previous rounds," was struck on a compara-ly sound spot. This round indicates what our 11-inch smooth-bore ; to speak of larger calibres) can do against French Gloires, British al Oaks, and similarly plated wooden frigates. Considerably less n 2,000 foot-tons, lodged in a round steel shot, will suffice to crush in sides of the ships, and a shot from the 11-inch Dahlgren, with 30 nds of powder, would exert a power of about 2,500 foot-tons at 500 ds. Referring to these, and similar experiments, the Times, last r, said:

If any certain conclusion can be deduced from the long series of eriments which have been made on this ground, it is that armor-ting as applied to ships is really as vulnerable now to our present nance and projectiles as the wooden frigates ten years ago were le to be knocked to splinters by the old 32-pounders and 68's. There o blinking or concealing this plain fact. There have been wonderful gets tried at Shoebury, and the best of all was that of Mr. Chalmers; ; their victory over the guns has ever been, as we have said, but of most temporary duration. The limit of weight in armor-plating ich a sea-going frigate can safely carry has been fully reached, if, leed, it has not been overpassed."

BOX-BATTERY IRON-CLADS.

These trials, and the comments they have given rise to, have sorely d the patience and taxed the ingenuity of European naval con-uctors. But instead of adopting the course pursued in our navy, of wing as little as possible above water and effectively protecting all t is exposed, they have imitated the Irishman, who to lengthen his nket cut a piece off the bottom and sewed it to the top. They pecially M. Dupuy de Lôme and Mr. Reed) have deprived one por-n of their ships of all protection whatever, in order to give another t such weight of plating as may for the present moment seem ficient. The only French ship shown in section, the Marengo, one the very latest designed and not yet completed, will illustrate this. r hull is the same as that of any wooden frigate, save that the bow, 20 feet or so, is of solid timber and covered by a brass cleaver, the p being intended to act as a ram. Though, as regards her hull, the rengo is a wooden ship, she is much stronger, having iron beams and es. Her protection consists of 7½-inch plating, from three to four feet ve the water-line to about seven feet below, the belt of armor tapering to about three inches at the lower edge. In midships, she has a bat-y 65 feet in length, protected on the sides by plates six inches thick.

This battery is protected fore and aft by a bulkhead of similar scantling to the ship's side, and plated with 4½-inch plates, which reach from the upper deck to several feet below the water-line. Thus the protected battery is a square box amidships, as shown in the woodcut.



French box-battery iron-clads.

This battery contains eight 7½-inch guns, four on each side, and when we consider that the funnel passes through it there cannot be much space for working these 8-ton guns. A fixed turret protects a turn-table mounting a 9½-inch, 13¾-ton gun, on each corner of the battery; the gun itself, however, being above the turret, is exposed. The total length of the ship is 300 feet, consequently a length of 235 feet on each side, or an area of about 4,500 superficial feet of the side of this new iron-clad, (?) has no more protection than any wooden frigate of the old type. Granting that the small box-battery amidships is invulnerable, the unprotected parts, with the masts and rigging, would be easily set on fire, the smoke and heat of which would drive the men away from the unprotected turret-guns, and interfere with the loading and training of the guns inside of the battery, whilst the demoralization of the crew, arising from the knowledge that both ends of the ship were on fire, would be as difficult to allay as the fire itself, and fully as disastrous as the enemy's shot.

FRENCH IRON-CLADS.

In the same case with the Gloire model, there is a model of an iron-plated frigate of the Flandre type, of 900 horse power, with a four-bladed screw. This vessel is short and broad, but the lines are well formed. There is also a model of the iron-plated frigate Solferino, with a ram bow and six-bladed screw. This vessel, like the Marengo, is only plated amidships, and along a belt at the water-line. The ram is triangular in its vertical profile, but it merges well into the well-formed lines of the ship.

There are also exposed in this case models of the floating battery Embuscade, of 120 horse power, a flat-floored, broad, and short vessel with guns all around, and driven by four-bladed twin screws; and a model of the floating bat-

tery Arrogante, also of 120 horse power, similar to the Embuscade, but reduced in height at the ends so as to form the greater part of the vessel into a central fort, carrying nine guns on each side and three guns at each end. There is also a model of the coast defence ship Bélier, of 530 horse power, in which the sides converge and are netted into the deck, and of which the armament consists of two guns set in a turret placed well forward to balance the weight of the machinery.

"The whole of these models," says *The Engineer*, "are exceedingly well executed, and the forms of the vessels are good for moderate rates of speed. But there is nothing in any of the arrangements that is worthy of imitation, or that shows that the advisers of the French government have attained any just appreciation of the powers and qualities indispensable to the success of modern ships of war. The most remarkable of these models," says the same journal, "is a submarine boat driven by a six-bladed screw at the stern. Motion is given to the screw by engines worked by compressed air, and an air-boiler or reservoir is placed near the bow to balance the weight of the engine, while another similar reservoir is placed upon each side of the vessel further aft. Midway down in the prow is a long tubular bowsprit or spur, carrying a torpedo at its extremity. The deck and sides are of course merged into one by carrying the sides in curved form over the upper horizontal surface, usually constituting the deck, and into this rounded top or deck a small boat is so indented that when in its place it forms a portion of the main vessel, but yet when liberated it is of the proper configuration to be suitable for a boat. This boat is also covered over, water-tight, and is entered through a hole in the bottom from the main vessel, a suitable manhole, closed by proper contrivances, being made in the socket which receives the boat on the deck of the main vessel to enable a person to pass from the one to the other. At the end of a small vertical shaft rotated by hand and projecting above the deck of the main vessel, a screw is set for the purpose of raising or sinking the vessel in the water. This model was executed at the port of Rochefort, and the arrangements exhibit ingenuity. But in many points the plan is inferior to that of D. Bushnell, projected in America nearly a hundred years ago."

THE NUMANCIA.

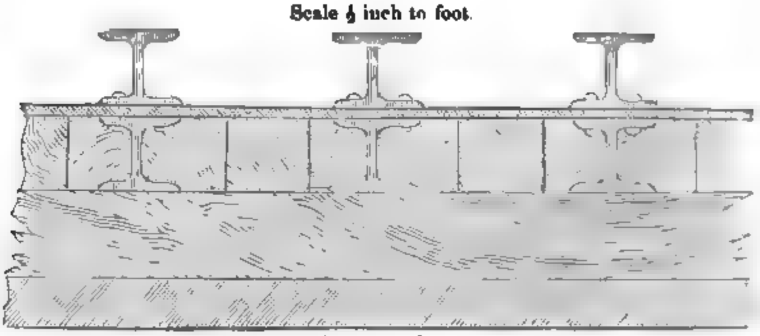
The exhibits of the private firms of France are not extensive. The Marseilles company, Des Forges et Chantiers de la Méditerranée, along with several models of marine engines, show a model of the Spanish frigate Numancia, which took part in the bombardment of Valparaiso and Callao. The Numancia is an iron ship, completely armored with 5-inch plating on 16-inch backing of timber, consisting of a horizontal layer of 4-inch planking, and vertical timbers 12 inches in thickness. On the whole the Numancia seems to be a more powerful man-of-war than any of the ships (as represented by the models) of the French navy. Though she is 70 feet shorter than the Achilles—the most powerful iron-

clad possessed by England[1]—she carries a greater weight of armor per square foot, (her armor-plates weigh 1,500 tons,) and is at least her equal in resistance to shot, while in consequence of the difference in length she is a much handier ship, and her cruise to the western coast of South America bears ample testimony to her sea-going qualities. This ship cost $1,579,000 without her armament. The Numancia was struck at Callao by a 300-pounder shot, which penetrated the iron plate and stuck in the backing. This shot, doubtless, struck obliquely, or was fired with a light charge, for there is little doubt that round No. 7 in the foregoing table, striking direct, would penetrate the side of the Numancia, as also would our 15-inch shot fired with 60 pounds charge at 500 yards.

GOUIN'S ARMOR.

Near by stands the only iron-clad model (in section) shown by a French firm. This is exhibited by E. Gouin & Co., of Paris, and, as yet, is only a project. It is a half section of an iron frigate with a double cellular bottom. Its chief peculiarity is its double H framing, of which we give an illustration. The object aimed at seems to be "a method of fastening

Scale ½ inch to foot.



Gouin's proposed armor.

with fewer through-bolts than are generally used." But the system involves constructive difficulties of no ordinary kind, such for instance as the fitting of the timbers *a a*, and the key-plank *b*, between the riveted H frames. The vertical frames, notwithstanding, their great depth and weight, being separated from the armor-plate by a cushion of timber planking, do not, as in the Chalmers system, support the plate, or offer any resistance to the shot till the plate and backing are first penetrated.

In the same class (66) Denmark shows a model of the stem or bow of a floating battery, built to carry two 300-pounder Armstrongs in one cupola. The length of this craft is 208 feet, breadth over all 40 feet, and depth of hold 17 feet; her draught of water being 12 feet. Her armor consists of a 4½-inch plate resting on a 12-inch timber backing, with horizontal stringers resembling the compound backing of the Chalmers target, or that adopted in the English frigate Bellerophon.

[1] "I feel bound to award the first place as a vessel of war, as a sailing ship, and as a steamer, to the Achilles."—Admiral Yelverton.

Further on, in the same circle, we come to a model of the Austrian frigate Ferdinand Max, which ran down the Re d'Italia, at Lissa. This is a wooden ship of La Gloire type, plated all round with 4¾-inch iron. She has 800 horse-power engines, and a displacement of only 5,100 tons. Her armament consists of 16 160-pounders, and her swan-neck shaped cutwater is armed with a cleaver, that makes her the powerful ram which, at Lissa, she proved herself to be.

TORPEDOES AND SUBAQUEOUS PROJECTILES.

Since armored ships have come into fashion, one would expect that more attention than heretofore would be given to the question of subaqueous artillery. Though the bottom of an iron ship is now, and is likely ever to be, a weak point inviting attack, there are very few contrivances for this mode of warfare on view at the Paris Exhibition. Some torpedoes are shown by the Austrian government which are chiefly intended for harbor defence. The following from *The Standard* has reference to these:

"The torpedoes, of which a specimen is exhibited, are flattened cylinders, about four feet high and the like in diameter. From the bottom a chain descends, and passes through a clip at the end of a long steel wire 7-strand rope, attached to a heavy bell-shaped or rather hemispherical iron anchor. The chain can be passed through the clip in one direction, but cannot be pulled back; by this means the crews of the boats laying the torpedoes can pull the chain through the clip until the torpedo is sufficiently submerged—say to 12 feet below the surface; the end of the chain is then let go into the water, and the clip holds it firmly in position. In this way each machine is successively moored. From the upper part of the torpedo there project at suitable intervals numerous large broad-headed iron studs, the long shafts of which penetrate into the top portion of the torpedo, and when any one of these studs is struck its shaft is driven against one of the teeth of an internal ratchet wheel, which partially turns and brings internal projections in contact with the electrical wires, when the exploding spark fires a composition somewhat similar to that of our Abel fuzes, but probably more sensitive. A special apparatus is necessary to permit the electrical currents to pass from all the torpedoes, and the same apparatus will test the insulation of each, as well as detect those which have exploded. The action of the contact made by the mechanical stud of the torpedo is that the current immediately passes to earth; when therefore a torpedo has been exploded its cable carries off to the water a considerable quantity of electricity, and it is requisite to sever its wire to avoid this loss. To detect it a bridge of copper is brought over from the connecting wire of battery to the apparatus to which all the wires of the torpedoes (Siemens's laminated copper small cables) are attached, and a short circuit is thus made with a needle-dial. As the circuits of the unexplored torpedoes are interrupted, no action takes place by connection with them; but when the one is touched

which is conveying electricity to the earth, or rather to the sea, the needle flies rapidly over and indicates the wire which should be cut adrift. The charge in these torpedoes is 168 kilograms, or about three hundred weight of sporting powder; the reduction is made in consideration of the immediate proximity of the explosion to the vessel sought to be destroyed."

With the exception of a crude model in the English section and another equally crude but more pretentious design in the French, there are no plans exhibited for firing submarine projectiles. We have been led to these reflections by the examination of the French model, M. Fourcy's "Batterie sous marin." His plan briefly consists in placing the muzzle of the gun into a stuffing-box, and forcing it outwards through an opening protected by a valve in the ship's side; when the gun recoils the valve closes and the operation is repeated. A submarine projectile possessing great novelty was lately discussed in *The Engineer*, and though the invention is not in the Exhibition it is none the less interesting. From the article in question we extract the following:

"It is somewhat extraordinary that, amongst the number of schemes of subaqueous explosion for warlike purposes, there is hardly any record beyond what we are now to make of subaqueous projectiles.[1] The ingenuity of engineers seemed to restrict itself to the proposition of establishing a mine at some fixed point in a channel, and then allowing it to stay at rest until an enemy's vessel might happen to pass over it, when by some sufficient device the mine should explode. Yet it would seem more desirable, if it could be effectuated, to launch a subaqueous projectile against a ship than to await the contingency of a ship passing over a stationary mine. The only sort of subaqueous projectile that comprises the conditions of prolonged flight—if flight be the appropriate word for such a medium as water—is the rocket; and granting the rocket's competence to take effect in a watery medium, then the use of this missile demonstrably presents enormous advantages over every other projectile that could be launched against a ship. Long before 1862 it had been known that a rocket would propel itself through water, and therein generate considerable projectile force; but the specific novelty of the proposition laid before the British admiralty in November, 1862, was that of regulating the subaqueous flight of an iron rocket by a system of flotation and pilotage, which, when explained, cannot fail to manifest its own advantages. An ordinary iron rocket being slung at a definite depth below the water-line by means of two metal stays from any convenient float, has pendent from it a rudder. Obviously the depth of the rocket below the water-line will be regulated and determined by the length of the stays, and the dimensions of the rudder would be regulated by experience. A rocket thus arranged when ignited, as might readily be accomplished by electricity, would obviously tend to go straightforward until the exhaustion of its propulsive force. Unlike an aerial projectile, which

[1] Fulton designed a submarine battery about the beginning of the century, the drawings and specifications of which were in existence not more than two years ago.

may incur deflection in any plane, a subaqueous rocket, arranged as here described, could only experience deflection laterally, vertical aberration being prevented by the float and regulating stays. A rocket, however used, is endowed with certain advantages an ordnance projectile has not. To the dimensions of a rocket there are hardly any imaginable limits; then, again, its first moment of flight being attended with no initial shock, many explosive bodies may, if desired, be used for charging rocket heads, though wholly incapable of employment by ordinary artillery. To fire a slung rocket, like the one just described, from a ship against a ship, would not be very difficult, but the special service indicated to the war office and admiralty, as falling within the province of these slung rockets, was that of establishing a perpetual protection at harbor mouths. It is easy to understand that an entire coast-line might be converted into a battery of such slung rockets at convenient distances apart, and converging, if desired, towards one or more points whereat a hostile fleet might be expected to pass. Equally easy is it to understand that any number of these slung rockets might be kept in perpetual communication with an electric reserve, whereby they might be discharged when necessary."

BELLEROPHON 6-INCH PLATE.

Before passing to the British Naval Department on the banks of the Seine, we shall examine the exhibits of the several armor-plate makers which are scattered about the parks and main building. Very fair specimens of plates, of from 4½ inches to 6 inches in thickness, are exhibited by Russia, Austria, Italy, and other continental countries, but the chief displays of this branch of war material are those of France and England. The former are chiefly of small dimensions, though some are nine inches thick. They are exhibited by the makers, of whom Messrs. Petin & Gaudet are the most extensive producers. Some of the French plates exhibited have been fired at, but chiefly with cast-iron shot, and from guns of small calibre. They are only slightly indented with the rippling, saucer-shaped mark invariably produced by cast-iron round shot, and these, as well as two short plates nine inches in thickness, with six 9½-inch shot sticking in them, exhibited by the French government, are shown to illustrate the quality of the plates and their powers of resistance. On the other hand the plate exhibited by the British government is shown to illustrate the power of the Woolwich gun and projectiles, and is, as before stated, completely riddled. This plate is 20 feet long, four feet three inches wide, and six inches thick. It was made at the Millwall Iron Works for the Bellerophon target, and it will be interesting to inquire into the circumstances and particulars of the firing that produced the terrible effects exhibited; for not only is the plate riddled, but the laminæ has been separated at the back for about six inches, all around the hole, whereby an amount of metal, fully equal to the weight of the shot, has been converted into langridge and driven into, and sometimes

through, the backing. There is a something about all these armor-plate trials of the British admiralty which is perplexing to the uninitiated, and these Bellerophon trials are no exception in this respect. When the Bellerophon target was first tested no shot was fired at it, but such as previous experiments had demonstrated would not penetrate. The reporters for the press on that occasion noticed its "merciful treatment," the "unusual tenderness" of the trial. So the plate shown in the Exhibition was not on the Bellerophon target when it received the punishment referred to; but it was on a *much stronger* target, called the "Box-target." The Bellerophon has only 10 inches of wood-backing, but this had 18 inches, with a double skin, and the usual iron frame. The following table gives the particulars of eight rounds fired at this plate, the effects of which as exhibited in Paris show both the power of the gun and the vulnerability of the frigate whose armor the plate represents. The gun used was the 7-inch 6½-ton M. L. naval gun, and the charge in each round was 22 pounds of L. G. rifle powder. The range was 200 yards:

Rounds.	Projectile. Nature.	Projectile. Weight.	Striking velocity.	Work in foot-tons.	Remarks.
No.		*Lbs.*	*Ft. pr. sec.*		
1	Chilled shot, 13.62 inch	117	1,338	1,432	Penetrated armor-plate and stuck in backing.
2	......do	116¼	1,331	....	Penetrated to inner skin, which was slightly bulged.
3	Chilled shot, 14 79 inch	......	....	....	Penetrated target completely, but skin was here only half an inch thick.
4	Chilled shot, ogival head, 13.86 inch.	115¼	1,337	....	Complete penetration of target.
5	Chilled shot, ogival head, 13.86 inch.	116¼	1,333	....	Complete penetration of target.
6	Steel shot, ogival head, 15.25 inch.	115¼	1,360	....	Complete penetration of target, shot picked up inside whole.
7	Steel shot, round-head	115	1,380	1,518	Struck on rib, or stringer, penetrated plate and backing, 18 inches, rib cracked and forced slightly back.
8	......do	115	1,371	1,499	Penetrated plate and lodged in backing total indent about 14¼ inches.

Though only four of the above rounds *completely penetrated* the target, there can be little doubt that all the eight rounds would have gone clean through the original "Bellerophon target." Thus the resisting powers of the Bellerophon gave way before 1,500 foot-tons, an amount of work (making every allowance for the different form of projectile) within the capacity of our 11-inch smooth-bores at 200 yards, or the 15-inch gun at 2,000 yards.

The contemplation of this riddled plate of six inches of solid iron again forces the question upon us, "Where are we to look for resistance to shot if not to increased thickness of the iron-plating?" There can be little

doubt, since every armor-plate must have a cushion of some sort between it and the ship, that this *cushion* or *backing* is the source whence increased resistance is to be obtained. In the shed adjoining that in which this Bellerophon plate is exhibited, this principle of improving the backing has two exponents. A plan of corrugated steel plates is shown by Mr. George Redford, of London, the resistance of which has not yet been tested by experiments; but the trials of steel armor-plates which have been made from time to time hold out little hope that steel in any shape exposed to the impact of shot will give a superior or even an equal resistance to iron.

The other plan is that of Mr. Chalmers, already referred to, whose original target was faced with hammered plates of only 3¾ inches in thickness. As the comparative resistance of the 3¾-inch plate on a compound backing and the 6-inch plate on a timber backing will help to answer the question proposed, we give the following from *The Times*, The writer, in summing up the results of the Bellerophon trial, ascribes to the target "a victory almost as great as that achieved by the target of Mr. Chalmers."

"In estimating the relative merits of the two targets," says *The Times*, "it must not be forgotten that Mr. Reed's target is larger by some 40 superficial feet than Mr. Chalmers's. In thickness of metal it is 20 pounds per square foot heavier, and its cost of construction is £400 more. To these facts we may add that Mr. Chalmers's target was assailed with 15 rounds more than were fired at Mr. Reed's yesterday—15 rounds which were fired with 150 pounds of powder, and threw no less than 1,500 pounds weight of metal against the target of Mr. Chalmers more than were fired against that of Mr. Reed."

The comparisons drawn from the experiments by the iron-plate committee are equally conclusive on the subject of improving the backing. During the present year the old "Chalmers target" was (after resisting 45 rounds) attacked by shot similar to those employed in rounds three, four, five, and six, of the foregoing table, save that in this case a 7-ton gun was used instead of the 6½-ton naval gun, and a stronger brand of powder, which gave an average velocity of 100 feet more per second, with a proportionate increase of *work*. The shot, according to the published reports, failed to penetrate the target, which is 24 pounds per square foot lighter than the "box target" covered with the Bellerophon 6-inch plate.

If thickness of plate and perfection of manufacture could secure immunity from penetration, the plates exhibited in this shed by Sir John Brown and Co. of the Atlas works, Sheffield, are well calculated to inspire confidence. Here is a 6-inch plate, 30 feet long and 3½ feet wide, and a massive slab 13½ inches thick cut from the solid shield used in the granite casemate at Shoeburyness. But a visit to the government shed hard by, at once destroys the feeling of security inspired by the contemplation of these ponderous masses of iron. There the counterpart of the 6-inch

plate is shown riddled and torn to fragments by a comparatively light gun with 22 pound charges of powder; and the identical 13½-inch shield is shown broken in two, by a few taps from projectiles less than half the weight of our 15-inch shot, and with less than half the work that can be got at 1,000 yards from our 15-inch smooth-bores. We by no means wish to detract from the value of these ponderous forgings, or the credit due to those who have produced them. Our object is to arrive at a true estimate of their worth as a means of defence, and to keep in view the fact that thinner iron, *properly backed*, would give an equal, perhaps a better protection at less than one-half the cost. Quite recently the Atlas Company have excelled all their previous productions by the successful manufacture of a plate of 21 tons, over 20 feet long, 4 feet wide, and 15 inches thick.

15-INCH PLATE.

The following, extracted from a description of the operation in *The Times*, is interesting if only to indicate the cost at which such plates are produced. After a graphic description of the foundry and the process of "drawing" the plate, the writer goes on to say:

"A great deal of the success depends upon the time at which the plate is drawn, and the amount and length of time to which it is to be heated. All this is regulated by the chief roller and furnace-man, who are paid wages which many eminent professional men might envy—wages amounting from £1,200 to sometimes £2,000 a year. * * * * The required dimensions were obtained, as we have said, by less than a quarter of an hour's rolling, and a plate 15 inches thick, the product of the labor of nearly 200 men, and the consumption of nearly 250 tons of coal, was shot out by the rolling mills and left to cool."

The Atlas Company also show specimens of spherical steel shot from 7-inch to 20-inch diameter; the largest weighs 1,155 pounds.

Two naval temples of equal size stand on the banks of the Seine, one above and the other below the *Pont d'Iena*, the former dedicated to the naval display of France, the latter to that of Great Britain. As the French marine models have been mentioned already, it remains only to say that the building on the Seine is almost wholly occupied with the engines and boilers intended for the iron-clad frigate Friedland. It is not our province to discuss these or any other marine engines, but there is a novelty about the Friedland's engines, which, combined with the facts that they are the exponents of the principle of construction adopted at the instance of M. Dupuy de Lôme for the engines of most of the ships of the French navy, and that they are the only large marine engines exhibited in motion, may justify a few extracts having reference to the principle on which they are constructed.

FRENCH MARINE ENGINES.

"The French three-cylinder engines," says *The Engineer*, "take their steam direct from the boiler into the centre cylinder only, and expand

thence into the two contiguous cylinders, all three being of the same diameter, and having the same stroke of piston. It is an object, in expanding, to obtain as nearly as possible the same mean effective pressure per square inch in the three cylinders, and this is attained in M. Dupuy de Lôme's engines by regulating the point of cut-off and the angles of the three-throw cranks with respect to each other. So far from being equidistant from each other, as so many cursory observers have supposed, the cranks of M. Dupuy de Lôme's two expansive cylinders are but 90° apart from each other, while that of the intermediate high-pressure cylinder is 135° from either of the others. With 25¾ pounds steam in the boilers, reduced to, say, 25 pounds at the middle cylinder, and cut off at five-sixths of the stroke, the steam is first expanded into one of the side cylinders and then into the other, and, when the back pressure on each of the three pistons is measured, it is found that the mean effective pressure upon the three pistons is practically the same. * * * * The steam enters the cylinders through what in other engines would be the exhaust port. The live steam enters the cylinder from the *inside* of the slide-valve, the exhaust being effected by the outer edges or ends of the valve. The steam, furthermore, on its way to the middle cylinder, passes around the two expansive cylinders, thus keeping them hot with steam of a much higher pressure than that worked within them."

Many eminent American engineers hold the opinion that the division of power and multiplication of parts, consequent on the use of *two* cylinders, is justified only by their greater certainty in starting or reversing as compared with a single cylinder. In either the single or double cylinder engines full advantage may, in an emergency, be taken of accumulated steam. But, says *The Engineer :*

"A great defect of this French system is that the expansion is invariable, and that the three cylinders cannot be made to work up steam, each on an emergency, as in chasing, or escaping, or ramming, of full boiler pressure, or nearly so. If, too, the ship is to work with half-boiler power, no advantage can be taken of increased expansion, but the steam must be throttled, and the same rate of about two-and-a-half-fold expansion maintained."

These engines of 950 nominal, are intended to work up to 4,000 indicated horse-power, and they weigh with full boilers 800 tons. The crank shaft is connected to the four-bladed screw by a universal joint, an improvement by which the heating of journals will in a great measure be prevented.

BRITISH NAVAL DISPLAY.

Below the bridge of Jena, we enter the building which contains the British naval display, a marine museum grand in its proportions, carefully arranged, and complete in all that is necessary to illustrate the English idea of a modern man-of-war.

We take the opportunity here to express our deep regret that the

United States War and Navy Departments have not sent to this Exhibition a selection of war material, such as would indicate the progress made in our country in ordnance, projectiles, and naval construction. A series of models, such as we have at Washington, would have done us great credit, and would have afforded our people a better opportunity of competing with French and English ship-builders and ordnance manufacturers in supplying munitions of war.

On the wall, facing the main entrance of the British naval shed, the Admiralty alone show upwards of 100 half-block models of ships, arranged and classed according to their respective dates of construction, and the type or rate of each ship they are intended to represent. They show besides about 20 or 30 models in section; and the exhibits of private firms are both extensive and varied. All this is in strict keeping with the genius and aspirations of the British people. "If," (said one of the leading newspapers lately, "we have any strength at all it is at sea. If we have any means of maintaining, not only our position among our equals, but our independence, it is in our ships. We are not great in land armaments as our rivals are. We cannot equal them in powerful armies and in military capacity. We have only the sea as our battle-ground, and maritime skill is our national defence."

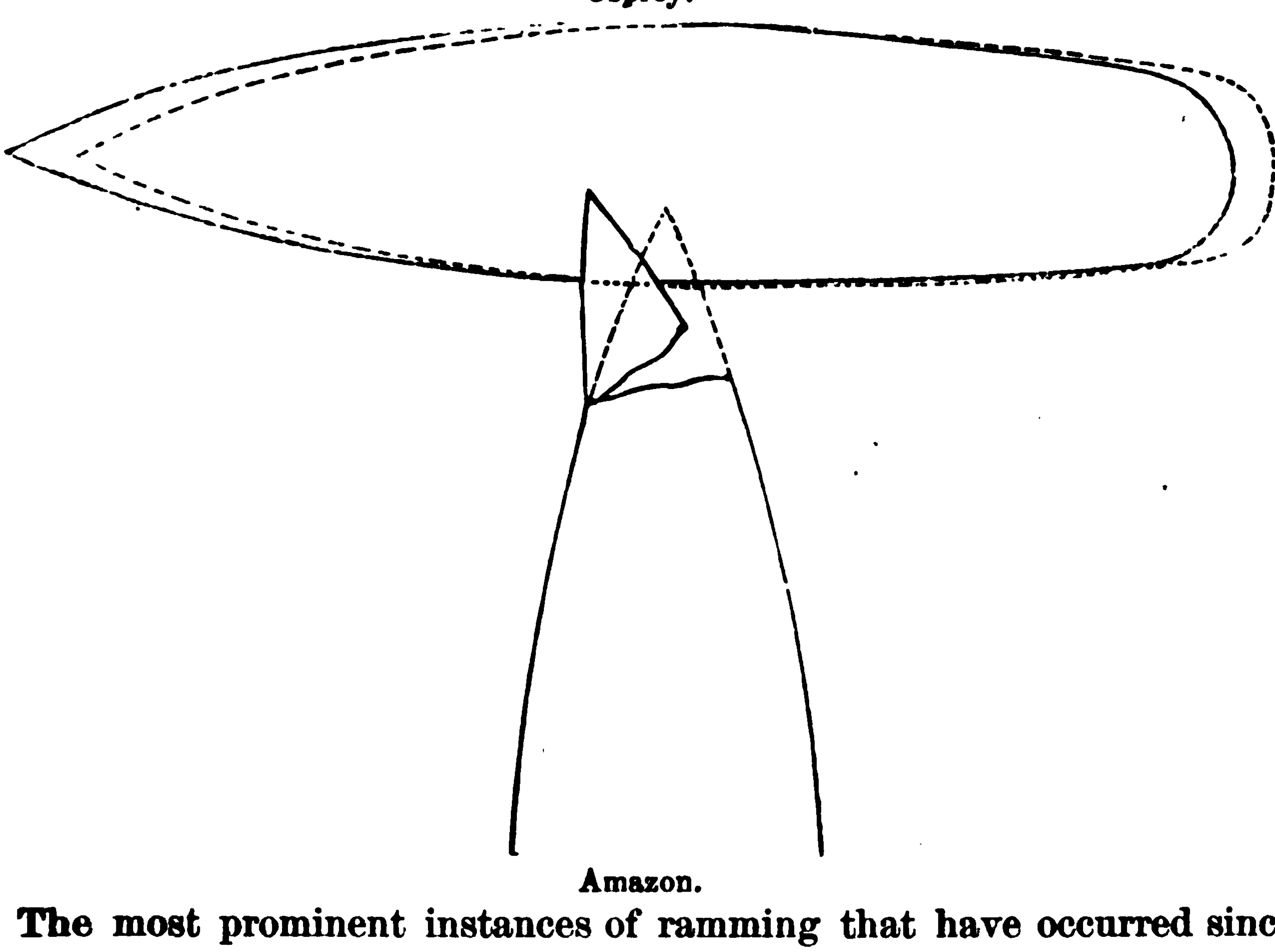
Half a dozen years ago, when La Gloire and the Warrior were new ships, when Palmerston forts and the French invasion formed the chief topics of interest in the London journals, the English navy was compared or contrasted with that of France alone. But all is now changed. British ships and guns are contrasted still, but American Monitors and Rodman smooth-bores have taken the place of the ships and guns of France.

The long continuance of the *entente cordiale* with the latter country has led the English people to look across a broader sea than the English channel for a probable maritime foe. This, in connection with the more significant fact that the United States has never had any other enemy at sea, cannot fail to make the English naval display in Paris interesting to Americans.

It is not, however, our intention to notice in detail this extensive collection of models or even every class which they represent; some idea of the perplexing, and doubtless unnecessary, variety of ships in the British navy, may be drawn from the fact that each of the 102 models exhibited is different in some respects from all the others. When there are two or more ships of a class, only one model is shown; thus the model of the Warrior is also the model of her consort the Black Prince. The converted wooden ships of the Royal Oak class, four in number, are also represented by one model, and so with the ships of the Alabama class, vessels of 1,081 tons. These, six in number, are represented by the model of the Amazon, which was sunk in the channel in July, 1866.

AMAZON AND OSPREY.

Here *en passant*, let us for a moment consider the loss of this vessel in connection with the ram principle of attack. The Amazon, it is true, was a wooden ship, but she was fitted with a projecting prow, armed with a strong cleaver of cast-brass for the purpose of being used as a ram if occasion required. If she was, comparatively speaking, a small ship of war, the vessel she ran into was only a small coasting steamer of less than half her tonnage. Hence it is reasonable to conclude that the projecting prow of the Amazon was as formidable to the Osprey as that of the Bellerophon would be to the Miantonomoh, and that it would, in proportion to the weight of the ship, be as strong as the prows of iron-built and iron-plated ships generally. When the Amazon ran into the Osprey, the latter was steaming across her bows at the rate of about ten knots an hour, and the effect of the collision will be understood by the following lines:



The most prominent instances of ramming that have occurred since armored ships were built have happened in cases where the ship attacked was either at anchor or going at slow speed. If a ship of the Minotaur or Bellerophon class were to run square into an iron-clad crossing her bows at ten knots an hour, it is quite likely that, as in the case of the Amazon and Osprey, they would both go to the bottom. The water-tight compartments of the ram would doubtless save her from such a fate, if she were to strike at a speed of five or six knots. But to get a blow at a ship going at the rate of ten knots, it would be necessary to surpass her in speed, in which case the shock would be sufficient to rupture her own bulk-heads, if not to tear her engines from their bed.

WARRIOR CLASS OF IRON-CLADS.

Passing by the models of the wooden three-deckers and other timber-built ships as either obsolete or too well known to be discussed here, we come to the armored Warrior, Britain's first iron-clad. The nature of her armor has already been noticed, and a thin red line on the model denotes how far that extends. The Warrior, a ship of 6,109 tons, is 380 feet in total length, and the sides are protected in midships throughout a length of 203 feet, leaving 81 feet forward and 96 feet aft, without any other protection than her iron skin of ⅝-inch plate. The plated battery protects 26 of her 40 guns, the remaining 14 being in her unprotected ends. Her fore and mizen masts will indicate sufficiently above the smoke of battle the position of this armored battery. The armament of the Warrior consists of 36 68-pounders and four 40-pounders, Armstrongs—an armament too light to fit her to cope successfully with iron-clads even of her own class. To work her broadside guns effectually, a considerable freeboard is necessary, and this is dependent on the safety of her unprotected ends. These penetrated between wind and water, which can be done by naval ordnance of any calibre, and the Warrior would settle down till her port sills would only be a foot or two above water and the ship herself quite unmanageable—in short, water-logged. A few extracts from the "opinion of Rear-Admiral Dacres" regarding this and other British iron-clads, contained in a return to an order of the House of Commons, (March, 1867,) will enable us to form an estimate of their qualities as ships of war:

"Without entering into the time they (Warrior and Black Prince) take to wear, or stay under sail—which defect is obviated by using steam to assist the manœuvres, and steam must always be kept ready for that purpose, whether in crowded waters like the Channel or in blockading an enemy's port—I will at once state that I have seen the great difficulty that is always experienced, even by skilful and practiced officers, in taking up a berth in a tideway under steam; the risk incurred in putting into such harbors as Cork and Lisbon, except with an ebb tide, which arises from their great weight necessitating their being brought head to wind or tide before anchoring, and the positive danger that would attend entering any crowded harbor with a squadron of such ships, where there might be no room, either from the number of vessels at anchor or the vicinity of shoals, for the ships to round-to, head to wind, to take up their berth.

"Another and serious defect is, that they are dangerous in scudding: the Warrior on one occasion came up nearly eight points against the helm.

"My observations of these vessels have been hitherto in circumstances of comparatively moderate weather; of their probable qualities and behavior in a heavy gale I am not inclined to think highly. Rolling 52° with a very quick motion (as I believe the Warrior did on her passage

to Lisbon in January, 1862) is a severe trial for any vessel, though, in justice to the contractors, I must say that in general weather they are remarkably steady, and only in a really heavy sea would they show these uneasy propensities. Their length and want of buoyancy, even with their unarmored ends, subject them to shipping water through the stern cabin-windows in circumstances of wind and sea, when in a wooden vessel no one would think of putting in a dead-light. This fact, and the undoubted superiority in buoyancy of these light-ended ships over the Hector, Price Consort, and Research classes, makes it a question for very serious consideration, whether any of our iron-clads that may be required for service beyond that of block ships in the Channel should be completely armor-plated, forward and aft, except by a belt at the water-line.

"As the speed of a steam fleet is only equal to that of its slowest ship, so the recent evolutions with ships of such different length and form have gone far to show that the rapid manœuvring of a fleet must be regulated by its longest ships, for the diameter of the circles described by Black Prince and Warrior being, say 1,000 yards at moderate speed, a fleet of which they form part must move in circles with a radius of 500 yards instead of about 250, which could be done by vessels of the length of, and steering as readily under steam as, the Hector; but to convince of the unhandiness of these vessels from their length with the present means in our power of steering ships, I need only add, that where other vessels require only to be two cables apart, the Warrior and Black Prince must be kept four cables."

Leaving the Warrior and Black Prince we come to the Hector and Valliant ships, plated on the same system, and with the ends similarly exposed. They are of 4,089 tons, and 280 feet in length. Their armament is similar in its nature to that of the Warrior but they only mount thirty-two guns each instead of forty as in the Warrior. Of these ships, Admiral Dacres says:

"The Hector is, I fear, the worst of the large class of iron ships, although the number of her guns in each broadside has been reduced. She is, I think, when complete with coals and other stores, far too deep to encounter heavy weather, as from her want of buoyancy in moderate weather in the Channel, the sea breaks most uncomfortably up her broadside, rendering the fighting of her guns nearly impossible from the quantity of water which would be shipped if her ports were open, and would soon flood the decks, and, if not battened down, penetrate below; she pitches very deeply, and is quick in rolling; she is iron-clad from the water-line upwards, which, of course, protects the men at quarters, but leaves exposed her most dangerously vulnerable part—the water-line, and this, in a ship of her rolling capacities, would make it easy to sink her, a fate more to be dreaded than the entrance of shells."

The Defence and Resistance come next in order. They are also 280 feet in length, but their tonnage is only 3,720 tons. Admiral Dacres

gives the Defence a higher character for sailing qualities than either the Warrior or Hector. He says:

"She has always been as handy in stays and in wearing as any one could desire, and is in fact a safe vessel under all circumstances of such weather as I have seen her in. She can at all times be trusted with her screw up; under steam she is a serviceable, good vessel, expending comparatively little coal. * * * * For all varieties of general service I prefer the Defence and Resistance to any of the iron-clads I have seen. The defects are the exposed stern and rudder; the first might be remedied so far as to prevent the lightest shot penetrating, cutting her wheel ropes, and injuring the head of her rudder on board. The wheel ropes are so led that one shot would cut all parts."

There is another defect of those ships that seems to have escaped the notice of Admiral Dacres, and which was forcibly pointed out by Sir John Pakington in the House of Commons. We allude to the fact that without the buoyancy of their unprotected ends these ships would sink.

These partially armored ships have water-tight bulkheads separating that portion of the hold which is unprotected from the protected part, so that though the stem and stern of the Warrior and Black Prince, Hector and Valliant, were shot away, or the fore and aft compartments filled with water, the ship would still float. But not so with the Defence and Resistance. After these ships were designed on similar principles to the others, which would have enabled them to float with the end compartments filled, the lords of the admiralty, on their own responsibility, reduced the length of the protected battery to such an extent that now the safety of these ships in battle will depend on a plate of iron so easily ruptured that an awkward blow from her own anchor swinging at the cat-head broke in the bow of the Defence.

IRON-CLAD ACHILLES.

The Achilles closes the list of ships with the Warrior armor of 4½-inch plating and 18 inches of teak backing. She is a vessel of 6,121 tons, 380 feet in length, and is plated almost throughout. Her armament consists of eight 6½-ton 9-inch smooth-bore guns, and eight 6½-ton 7-inch rifled guns on her main deck, and four of the latter on her upper deck. Her guns, unlike those of the other ships of her class, are able to penetrate such armor as her own. To this ship Admiral Yelverton (in a report included in the aforementioned order) ascribes the first place among the British iron-clads. He says:

"This remarkable ship, so grand and imposing in appearance, will, no doubt, (when her masts are properly placed,) realize all that has been expected of her as a sailing ship. As a fast and powerful steamer she takes her place in the highest rank, and combines sailing, steaming, and fighting qualities such as none of the others possess. Her power of going to windward in a breeze when her propeller is disconnected is astonishing, and her stability very great. In running before the wind,

she does not accomplish what I expected of her, but it is hardly fair to judge of the sailing qualities of a ship with her foremast placed where it now is. When under steam in the trough of a heavy Atlantic swell her rolling was trifling compared with that of all the other ships of the squadron. On the 17th October, when the Lord Clyde was rolling 26 degrees, and the Caledonia 28 degrees, the Achilles was only rolling 12 degrees. Again, on the 15th October, Caledonia was rolling 14 degrees, Lord Clyde 10½ degrees, and Achilles only two degrees. * * * * We must not, however, lose sight of the fact that with all her good qualities the Achilles is, from her great length, most difficult to handle; and this defect in action, more especially if engaged with a turret-ship, might be her ruin.

"It is, perhaps, going beyond the bounds of what is probable, but I feel certain that this ship might, and probably would, have to go out of action to turn round, thus exposing herself in almost a defenceless position to the fire of more than one of the enemy's ships. In the full speed trial of steam she beat the whole squadron considerably."

Without dwelling longer on the sailing qualities or other features of these seven ships of war, we append a table of a few rounds that have penetrated their representative target; passing over all rounds fired by guns of larger calibre than seven inches, observing merely that a shell fired with a 70 lbs. charge from the 13-inch Armstrong burst in the target and passed clear through, one of the armor-plates being completely blown off. The rounds in the table were fired at 200 yards range.

Rounds.	Gun.	Charge.	Projectile.		Striking velocity.	Work in foot-tons.	Remarks.
			Nature.	Weight.			
No.		*Lbs.*		*Lbs.*	*Ft. pr. sec.*		
1	7-in. M. L. Church	25	Cylindrical steel	100	1,555	1,677	Complete penetration, shot picked up 44 yards in rear after passing through mound of sand.
2	....do	20	....do	100	1,411	1,374	Complete penetration, shot went out to sea.
3	7-in. Shunt	25	Round-h'ded steel	100	1,531	1,625	Struck rib, complete penetration, shot went out to sea.
4	....do	25	....do	100	1,531	1,625	Complete penetration.
5	....do	25	Elliptical-headed steel.	101	1,498	1,572	Complete penetration, shot broke up.
6	....do	25	Cylindrical chill'd	102	1,500	1,555	Complete penetration, shot broke up.
7	7-in. Woolwich	25	Solid-headed live steel.	102	1,539	1,686	Through, setting fire to backing, head of shell out to sea.
8	7-in. Lancaster	25	Concave-h'd shell	137	1,418	1,731	Complete penetration.
9	....do	17	....do	137	1,220	1,417	Complete enetration.
10	7-in. Whitworth	23	Flat-headed steel shot.	140	1,270	1,443	Complete Penetration.

From these ten rounds we perceive that an average work of 1,500 foot-tons overcame the Warrior armor. But a more remarkable round than any of the above was fired from the Whitworth 7-inch gun at this target, after the four and a half inch plates had been replaced by others five inches thick. This round was fired at 800 yards range with 27 pounds of powder. The projectile was a flat-headed steel shell of 151 pounds weight, had a striking velocity of 1,165 feet per second, and 1,421 foot-tons of work. It completely penetrated the target, bursting in the backing and carrying many splinters inside.

MINOTAUR CLASS OF IRON-CLADS.

We have already referred to the retrograde step taken by the British admiralty in the armor of the Minotaur class. Imposing in appearance, and costing about $2,500,000 each, the Minotaur, Agincourt, and Northumberland are perpaps the least efficient ships of war in existence. They are built of iron and are completely armored with 5½-inch plating amidships, and 4½-inch plates at the stem and stern, upon a backing of timber of an average thickness of 9 inches. In resistance to shot they are believed to be inferior to the Warrior class, but the reports and transactions of the Iron-plate committee afford no data by which the resistance of these ships can be fairly compared. The following particulars of one round fired at each target may give an approximate idea of their respective powers of resistance:

Target.	Gun.	Charge.	Shot.	Velocity.	Work.	Effects.
				Ft. pr. sec.	*Foot-tons.*	
Warrior..	10.5-inch.	50 lb.....	Spherical cast-iron.	1,620	2,730	Penetrated plate and 13 inches of the backing, bulging inner skin.
Minotaur	10.5-inch.	50 lb.....	Spherical cast-iron.	1,620	2,730	Penetrated plate, lodged in backing, broke two ribs, and seriously bulged inner skin.

It must be borne in mind that the latter round was fired at a new target, while the Warrior target had previously received forty-five rounds. Owing to the greater thickness of the Warrior's side, the effect of the blow is distributed over a larger area, and in the absence of reliable experiments it is reasonable to conclude, with the Iron-plate Committee, that the resistance of these ships of the Minotaur class has been greatly impaired by the substitution of an inch of iron for 9 inches of timber. The Minotaur is a ship of 6,621 tons, and 1,350 horse-power. She is 400 feet in length, and in the matter of handiness and sailing qualities will probably rank with the Warrior and Achilles. Our 11-inch smooth-bore with 40-pound charges would easily penetrate the sides of the Minotaur and her consorts at 300 or 400 yards, while the 15-inch gun would do the same at 1,500 yards, with 60 pounds of powder; and if the same charge were used as that lately employed at Shoeburyness (100 pounds,) this gun would send its shot through the Minotaur, Agincourt, or Northumberland at 3,000 yards.

IRON-CLAD BELLEROPHON.

Time and space would fail us were we to speak of all the classes of iron-clads in this collection, so, leaving for the present the smaller vessels of the box battery class, we come to the Bellerophon, which is believed by Englishmen generally to be the most powerful iron-clad afloat. In resistance to mere penetration she is equal, perhaps superior, to the Warrior, but her want of a *cushion* or elastic backing will cause her to suffer more from the smashing effects of heavy shot. We will endeavor to explain this when speaking of the Hercules, which is in most respects a sister ship. In regard to the area protected (in this model the thin red line to indicate the extent of armor is wanting) the Bellerophon is inferior to the Warrior, her protected battery being 90 feet in length to 203 feet in the Warrior. With the exception of a belt of plating reaching a couple of feet above the load water-line, her sides afore and abaft the 90 feet battery are wholly unprotected. They have the disadvantage, as compared with the unarmored parts of the Warrior, that the skin is thicker, thus affording more metal to be converted into langridge under the impact of light ordnance or grape-shot. A round or two of case shot, (such as we have suggested when speaking of projectiles,) fired from a 15-inch or 20-inch smooth-bore into the unarmored ends of the Bellerophon, would doubtless consign her to a similar fate to that which overtook the Affondatore, or the partially-armored Palestro at Lissa, which was set on fire and finally blown up in consequence of a shell exploding in her unprotected cabins.

If, according to Admiral Dacres, "the speed of a steam-fleet is only equal to that of its slowest ship," the strength of a ship of war may be said to be equal to its weakest part. Viewed in this light, the Bellerophon is inferior as a fighting ship to the Minotaur, or even to a wooden frigate of equal speed and capacity. The Bellerophon is a ship of 4,270 tons, carrying engines of 1,000 nominal horse-power. She is 300 feet in length—nearly 100 feet shorter than the Achilles, a wholly armored ship. As the armor for the Bellerophon was sacrificed to secure handiness and speed, we refer to the opinion of Admiral Yelverton on these points.

"I cannot," he says, "call the Bellerophon a handy ship, for she possesses the defect common to all iron-clads, viz., that she will not pay off with certainty in spite of her after-yards being square, and helm up; and she is very doubtful in stays, even under the most favorable circumstances of wind and sea, having observed her miss stays three times on one occasion, and at length obliged to wear. This I attribute to the balance rudder, which may be well suited to a screw steamer, but seems to have a tendency to stop the ship's way too suddenly under sail, and she then refuses to come head to wind. Whatever may be the merits of the balance rudder, it has the great defect of offering a target of very large dimensions. The captain of the gun who would fail (at moderate range) to hit it, when the Bellerophon pitches, must be a bad shot.

Under all the circumstances of steaming, I think the Belleroph
below the Lord Clyde, and on a par with the Ocean and C
In this respect I was disappointed, for I expected much greate

BOX-BATTERY CLASS.

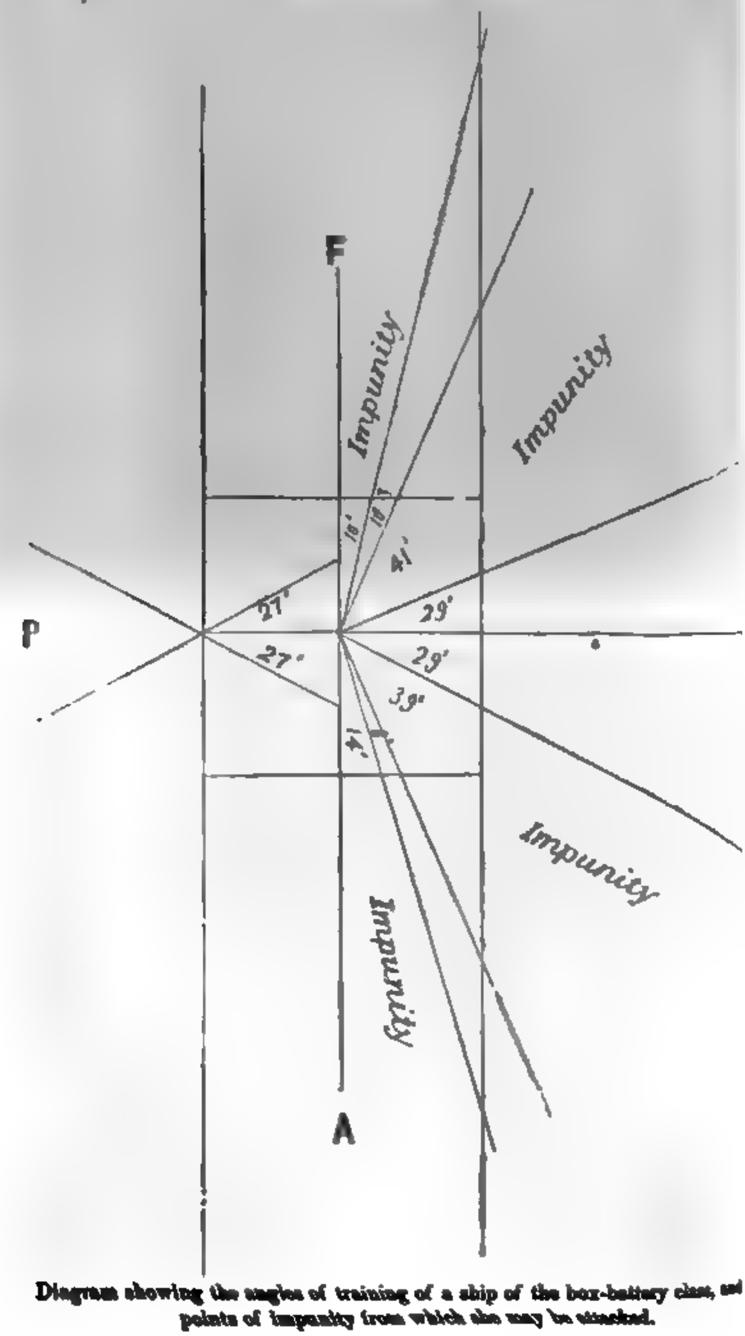


Diagram showing the angles of training of a ship of the box-battery class, and points of impunity from which she may be attacked.

The smaller ships of the box-battery class will be fitly represented by the Research. They are either wooden or composite ships, and have a small battery of about 40 feet in length protected by iron-plating of about 4½ inches in thickness. Armor-plated bulkheads connect the ends of these batteries, thus forming a square box-shaped enclosure amidships, similar in principle to the French frigate Marengo. A belt of armor-plating about four feet wide—three feet below and one foot above the water-line—runs around the ship, the remainder of the side above water being unprotected. Speaking of this ship, Admiral Dacres, in his report, says:

"The great defect of the plan of a box for the gun appears to me to be the number of points which are left for an active enemy of more speed to attack with perfect impunity; a diagram of the training of the guns at once shows this. Copies of these, given to me by Captain Wilmshurst and Commander Rowley, are enclosed.

"At a recent inspection at Portland, the Frederick-William, at two cables' distance from the Research, could not have been struck from the gun on the after broadside port, or by the same gun when shifted to the stern battery port on the same side of the ship.

"She might, I think, be easily carried by boarding, and if the enemy once obtained possession of the battery decks, shells or lighted canvas thrown down the hatchway would carry the ship.

"Clearing away the bulwarks for action takes too long a time. From the effect of a moderate sea on the port gate of the Research in the last cruise, I have no confidence in its power of standing the shock of a heavy sea."

THE MONARCH AND CAPTAIN.

Passing the Waterwitch, Pallas, and a fleet of fancy vessels, our attention is attracted by the models of the Monarch and Captain, turret ship, and turning to the official catalogue we find the following interesting parallel:

	Tons.	Length.	Draught.		Horse power.	Estimated speed.
			Fore.	Aft.		
		Feet.	*Feet.*	*Feet.*		
Monarch	5,100	330	22¼	26	1,100	14 knots.
Captain	4,272	320	22¼	23¼	900	14 knots.

Armament in both cases, four 22-ton guns, and two 100-pounders.

The former was designed by the controller and chief constructor of the navy, and the latter by the Messrs. Laird and Captain Coles.

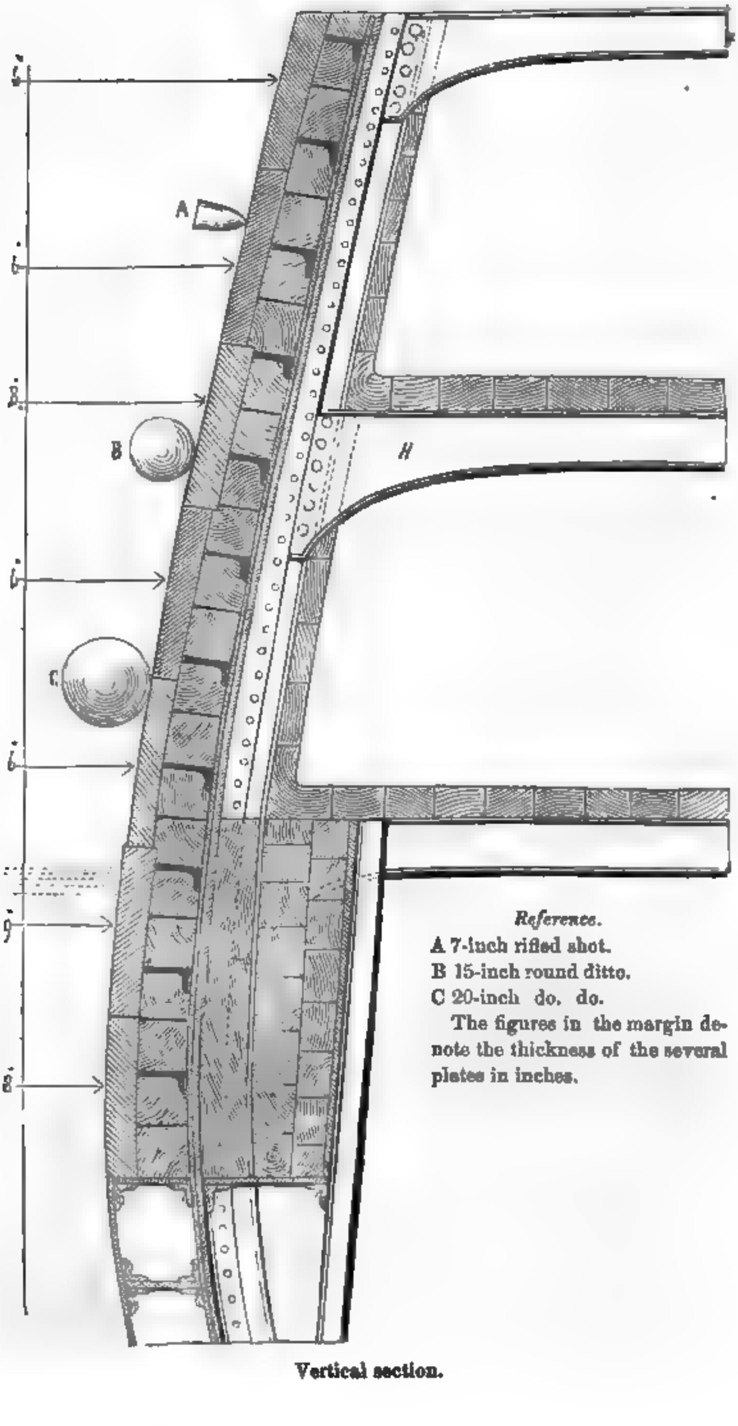
THE HERCULES.

With a few words about the Hercules models we close our inspection of this highly interesting naval display.

It would be difficult to imagine a case of more successful deception than that by which the British public has been led to believe that the armor-plates of the Hercules are nine inches in thickness. A target faced with an 8-inch and a 9-inch plate was set up at Shoeburyness and called the "Hercules target," and a full-size section of similar armor is shown in the Exhibition, ticketed "Section of Hercules target." True, a section on a scale of ½-inch to the foot is exhibited in a glass-case, which shows the actual armor of the ship, but the full size section takes the eye, and leaves an impression which cannot easily be effaced. We never remember having seen in any British journal any notice of this ½-inch scale model. Indeed it is doubtful if any of the conductors of the press, from *The Times* to the halfpenny weekly, are aware of its existence, or that the armor-plating of the Hercules is other than nine inches thick. Our woodcut, on a scale of ¼-inch to the foot, will show that the armor plates of the Hercules are the same thickness as those of the Bellerophon. She has, it is true, a 9-inch belt at the water-line, and an 8-inch belt on the line of the main-deck beams, but the plates which protect her battery and lower deck are only 6 inches thick. These plates have a backing of 12 inches of timber with a plentiful supply of stringers, after the plan of the Chalmers target. This backing rests on a double ¾-inch skin supported by the usual iron framing. The foregoing table, of eight rounds fired at the Bellerophon plate, will give a fair idea of the strength of the greater part of the Hercules armor. We find that a chilled shot fired with 22 pounds of powder, and carrying less than 1,500 foot-tons of work, defeated the Bellerophon plate on a much stronger backing than that of the ship itself. Hence, allowing for the extra two inches of backing, the Hercules would give way before a 7-inch rifle with a charge of 25 pounds and a power of 1,700 foot-tons, an amount of work which leaves a margin in favor of our 15-inch guns with battering charges. There can be little doubt that the water-line belt would prove too strong for the 15-inch gun, as it did for the 600-pounder Armstrong, but shot fired from an elevated position, or when the ship rolled more than ten degrees, could enter above the water-line belt and pass out through the other side below it, as shown in the following diagram.

The chief defects, however, of this ship and the Bellerophon are the unprotected ends, and the absence of any *cushion* to neutralize the vibration, when struck a racking blow on the side. The armor-plate (see woodcut of Hercules armor) bears on the horizontal stringer opposite shot B; this stringer rests on the iron skin, which in turn is rigidly connected with the ship's frame and the beam H. Now the 15-inch shot B, striking the plate with a remaining force (at, say, 1,000 yards range) of 4,000 foot-tons, would, if it failed to penetrate, paralyze every man on the gun deck in the region of the blow. At Lissa, a ball struck one of the iron deck beams of the Affondatore, and broke it asunder as if it *had* been a lath of wood. A steel shot of 490 pounds in weight would

"Hercules" armor. Scale ½ inch to foot.



Reference.

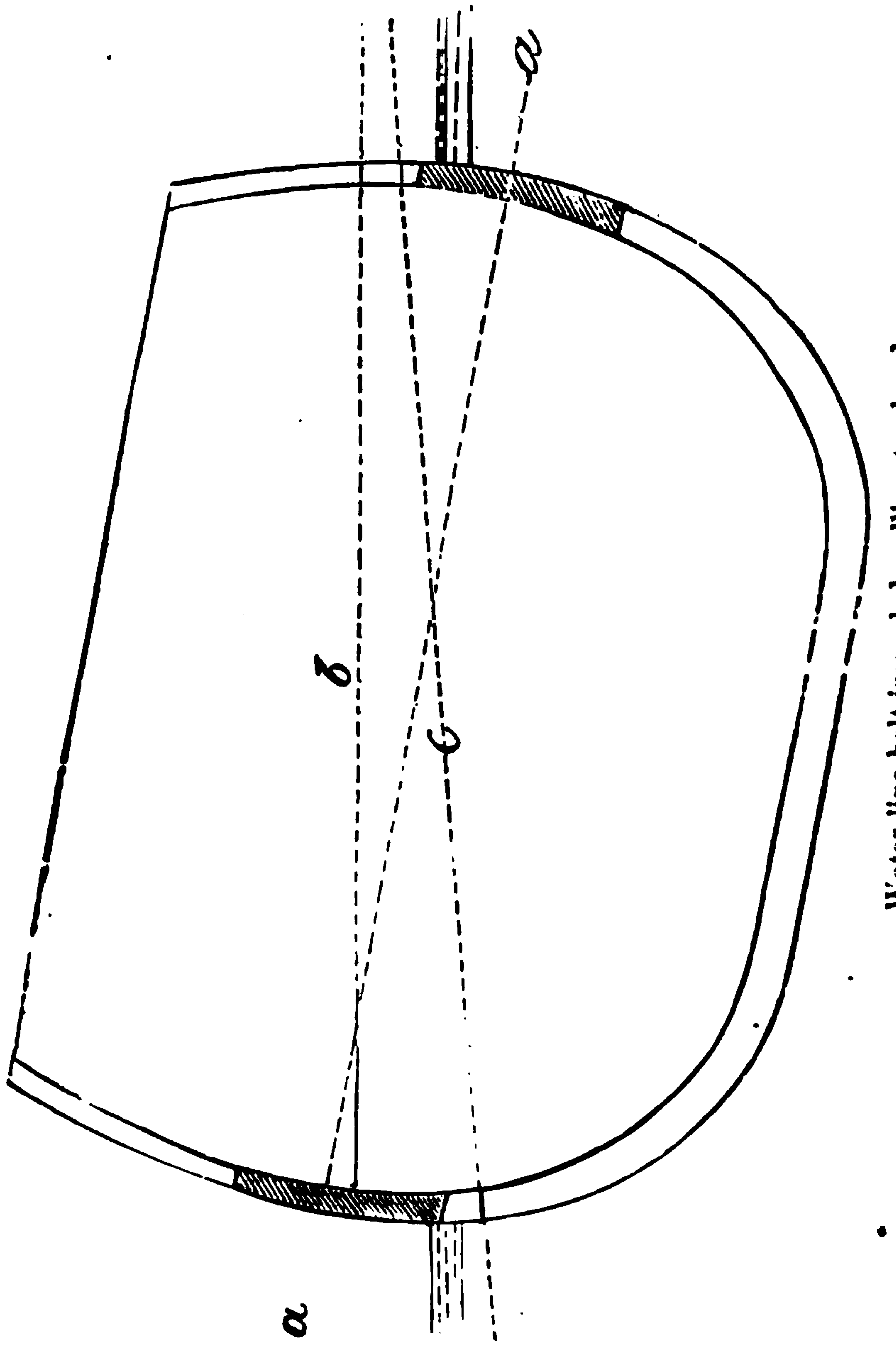
A 7-inch rifled shot.
B 15-inch round ditto.
C 20-inch do. do.

The figures in the margin denote the thickness of the several plates in inches.

Vertical section.

probably bend the beam and raise the deck, so as to render it difficult possible at all, to work the guns. But such a blow, though it might n prove fatal to any one, would doubtless disable, for a considerable tim

Reference: *aa* Water-line on even keel. *b* Trajectory of shot at ten degrees roll. *c* Trajectory at fifteen degrees.



Water-line-belt iron-clad, rolling twelve degrees.

all within a certain radius of the point of impact. Let any one who ma desire to test on a small scale the effects of such a blow, stand on a plan of timber, and get some friend to strike the end of the plank sharpl with a sledge hammer. A pointed projectile would not produce this pa alyzing effect. It insinuates its fine point into and through the iro plate, breaking itself to pieces in the act, and if there be a good dept of backing to absorb the pieces, it will prove a comparatively harmles missile. Against the thin sides, however, of the Hercules, Bellero phon, and British ships generally, it would prove very destructive. Th ogival-headed shot, as it does not rack like spherical shot, is not so hard on the fastenings. Since the introduction of these projectiles at Shoe buryness, fewer bolts have been broken than under the racking and buckling effects of round shot.

The two fore and the two aft guns of the Hercules battery are so placed that they can fire at a slight angle, about fifteen degrees, from the line of the keel. This improvement, however, has its defects; it necessitates the scooping out of large hopper-like recesses in the ship's sides, each of which will serve to collect, and direct into the battery, a shower of grape-shot, so as to rake every gun on that side of the ship. This arrangement is demanded by the new tactics for fast iron-clads—"to fight end-on and choose their distance"—or, in other words, to dodge and run away. These tactics imply sea-room, fine weather, and the finding of the enemy when and where it would be most convenient to fight him, circumstances not always comeatable. Nelson, who used to observe that "nothing is certain in a sea-fight above all others," like Paul Jones and other naval heroes, had often too much trouble to find the enemy, to be particular about when and how they were to fight him.

Respecting the sailing qualities of the British iron-clads very little can be said, save what is put on record by their own officers. Almost every day we read in the English papers of the American iron-clads being unseaworthy, though several of them have crossed the Atlantic and cruised in the Pacific, while no British armored ship, except the partially armored Favorite, has cruised in American waters, or visited the Pacific or Indian oceans. The following extracts from the reports of Admirals Yelverton and Warden, commanding the channel fleet during the experimental cruise of last year, will be read with interest:

ADMIRAL YELVERTON'S REPORT.

"On leaving Portland, September 20, the wind was fresh from the westward, and had been blowing hard from that quarter for several days. I found a very heavy sea and swell to the westward of the Lizard, so much so that I decided not to attempt to beat against it, but try the merits of the ships, simply as steamers proceeding under adverse circumstances to a certain point, maintaining a given moderate speed, and preserving, as near as possible, their exact formation in order of steaming, so essentially necessary for the performance of such steam tactics as might be required, had we been in search of an enemy.

"I may here mention that the cruising ground in the Atlantic selected for our trials was, for the object of meeting very bad weather, somewhat too far to the southward, as from the fall of the barometer, the state of the sea and general appearance of the weather, I have no doubt that on three occasions heavy gales passed between us and Cape Clear, affording on two occasions only, proof of their strength by the share we got of them."

After referring to the sailing qualities of the ships, the report says:

"When the signal was made to get up steam and lay out targets, it was necessary to place the ship's head to the sea before it could be considered safe to send the men aloft to furl sails.

"The precaution was then taken of battening down the main-deck hatchways fore and aft, and as the practice was limited to 15 rounds, five guns only on the port side were cast loose, and the practice commenced.

"It was found utterly out of the question to fire at the target in any other position than when head on to the sea, and the time occupied in firing the prescribed number of rounds was about three-quarters of an hour. It was necessary to steam round the target once or twice to bring the guns to bear when the ship rolled to 28 degrees, while it did not exceed 10 or 11 degrees when head to sea. The result was that the main deck was flooded with water to the extent of flowing over the hatchways, the water poured in and out of the guns, two shot rolled overboard out of them, and one was followed by the cartridge. Two of the guns at different times got the better of the crew, and banged in and out of the port several times with extreme violence, and two of the slides were to a certain extent damaged by it.

"It is needless to say that the practice was wild in the extreme, nor do I believe that at any time there was the least probability that we could have hit an enemy's ship except by accident or miracle. I did not observe any ship, except the Achilles, fire while in the trough of the sea, but she was comparatively quite steady. I have been since informed that the Hector did so likewise. Nor did all the ships fire the prescribed number of rounds, the Bellerophon only two, which shows a manifest desire to get their guns secured again.

"The result of that day's experience would seem to prove that it is possible (though certainly never desirable) to cast loose and fire these 7-inch guns in a seaway, either singly or a few at a time, with well trained men or experienced crews; but under the circumstances of that afternoon I hold that it would have been utterly impossible to have gone to general quarters or fought an enemy's ship.

"To have opened all the main deck ports, judging by the effect of opening only five, would have been to have washed the men away from the guns, and consequently they (the guns) would have taken charge of the deck by getting adrift, but with what consequences it would be utterly impossible to predict.

"The most of the cartridges, if not all of them, would have been destroyed in the guns, and the guns which could have been got off would have hurt nobody. Three times in the course of that afternoon did the ship roll her main chains right under, and threw the water on the upper deck. The lower sills of the main deck ports are about 8 feet 6 inches from the water when she is deep, and a roll of 15 degrees just touches the lower sill, and 22 degrees roll just about covers the whole part."

Admiral Yelverton, comparing broadside and turret ships, says:

"I do not think that on any future occasion I would venture to open a

port or cast a gun loose in any of these ships rolling more than 12 degrees or 15 degrees, for beyond that the practice would be very doubtful, and the certainty of shipping water very great.

"The turret system of arming a ship would have had a great triumph on this occasion, for there is no doubt that a sea-going turret ship, say 12 or 14 feet out of water, would have fought her guns without the slightest difficulty, and have fired easily six shots to every one from our broadside ships.

"Placed as the squadron was on the 26th September, a good turret ship would have been a most formidable adversary, and have done us serious injury."

Having no desire to represent these ships in an unfavorable light, we frankly admit that the foregoing extracts are such as relate to their performance in rough weather. The admiral commanding concludes as follows:

"It is not fair to expect an iron-clad to be as good a cruiser as an ordinary ship, but if she can keep her position under sail off an enemy's port, without having recourse to steam, and make the best of such weather as she will there find; if her powers of offence and defence in action are equal with what she will meet with on the high seas, and she carries a substantial armament, well mounted, and well out of water, all that could reasonably be expected of her as a cruiser is gained, and we must be content with a good steamer and a stout fighting ship, to the exclusion of a fast sailing one.

"Taken collectively, the ships have formed a very efficient squadron; they have cruised for more than a month continuously, at a stormy period of the year, and with the exception of a few spars and sails carried away, lists of which are hereunto appended, no ship has sustained any serious damage.

"I am not aware that such a result has yet been attained by an ocean cruising squadron of iron-clads of any foreign power."

POWERS OF RESISTANCE OF ENGLISH IRON-CLADS.

The data as to their resistance to shot have been derived from various sources—official and semi-official—and used so as to place this quality in its true light. The powers of resistance of each representative target have been calculated to a fraction in a paper read by Captain Noble, R. A., at the British Association, (1866,) and the value of each ship was estimated by her ability to pass batteries armed with our 11-inch and 15-inch guns. Thus, it is estimated that the Bellerophon could pass the forts at New York within 200 yards without suffering except by racking, and the Warrior could pass on the same terms at 800 yards. Captain Noble, however, limits the power of the 15-inch gun to a charge of 50 pounds, which gives a velocity of 1,070 feet per second, and 3,547

foot-tons of work at 200 yards.[1] But this gun has been fired at Shoeburyness with charges of 100 pounds, giving a velocity of 1,538 feet, and 7,405 foot-tons of work, a power sufficient to penetrate, at 2,000 yards, any iron-clad in the British navy. It must also be borne in mind that, as in the case of the Hercules, these Shoeburyness targets do not always fairly represent the ships whose names they bear. The Bellerophon target, for instance, represented only that part of the ship supported by and below the main-deck beams, while the 8-inch double-framed Warrior target, at which the Rodman gun was fired, is fully twice as strong as the Warrior ship. Apart from the so-called Hercules target, that of the Lord Warden was the strongest, as it unquestionably was the fairest, of all the targets professing to represent certain ships. The two following rounds therefore will give some idea of the strength of England's best iron-clad:

Round.	Gun.	Charge.	Shot.	Weight.	Velocity.	Work.	Effects.
		Pounds.		*Pounds.*	*Ft. per sec.*	*Foot-tons.*	
First ...	9½-in.	44	Cylindrical steel .	221	1,450	3,222	Through, and 500 yds. out to sea.
Second .	9½-in.	30	Cylindrical steel .	221	1,310	2,642	Complete penetration.

It must not be forgotten, however, that in England resistance to shot is not considered of the first importance in iron-clad construction. The Duke of Somerset, when first lord of the admiralty, at a meeting of the Society of Arts said: "If we are to have 300 or 400-pounder guns, it would be a question with me whether it would not be better to do away with armor-plates altogether and let the shot go right through;" and in a curious corresp ndence (lately published) the controller of the navy—the head of the construction department—says: "I have purposely avoided the subject of the relative resistance to shot of the several targets; it has no bearing on the question."[2] The British admiralty

[1] The following table gives the remaining velocities and work of spherical steel solid shot fired from American 15-inch and 11-inch smooth-bore guns:

Gun.	Charge.	Projectile.		Initial velocity.	At 200 yards.		At 500 yards.		At 1,000 yards.	
		Weight.	Diameter.		Remain'g velocity.	Work.	Remain'g velocity.	Work.	Remain'g velocity.	Work.
	Pounds.	*Pounds.*	*Inches.*	*Ft. per sec.*	*Feet.*	*Tons.*	*Feet.*	*Tons.*	*Feet.*	*Tons.*
15-inch.	50	484	14.85	1,070	1,028	3,547	969	3,152	[illegible]	[illegible]
11-inch.	20	189	10.85	1,080	1,019	1,361	936	1,148	818	[illegible]

Captain NOBLE, R. N.

[2] ADMIRALTY, *January* 23, 1864.

SIR: I do not wish to be uncourteous, and therefore, though I am much pressed for time, I will endeavor to reply to your note of the 18th, marked private.

The whole question between yourself and the admiralty I believe to be simply this: Can a ship be built in accordance with the design you embodied in your target, with advantage over the ordinary mode of building armor-plated ships?

I unhesitatingly give you my opinion that it cannot, and I have the best possible grounds

demand three qualities in an iron-clad, and in the following order: First, speed; second, handiness; and third, armor. Whether they are right in their classification or not, will only be known when these ships come out of action. The British iron-clad navy at present numbers about 30 vessels,[1] 18 partially plated, and 12 fully armored. That these ships combined would form a powerful fleet capable of inflicting great damage on a foe, cannot be denied, though the fate of the partially armored vessels at Lissa is suggestive of defeat to similar ships elsewhere.

NAVAL DISPLAY BY PRIVATE BUILDERS.

Many of the private cases in this naval shed are deserving of a closer inspection, and more extended review than at this stage of our labors can be devoted to them. Messrs. Laird Bros., of Birkenhead, obtained a gold medal for the model of the Captain, mentioned in connection with the government ships. She would doubtless be one of the most powerful iron-clads in Europe, but for her unprotected forecastle and poop; these not only prevent her turret guns from firing directly fore and aft, but are liable to be set on fire, which would seriously intererfere with the management of the ship, and possibly lead to her total destruction. To obviate the necessity for using one of her 600-pounders, when a light tap only is required, she carries two 100-pounders, and it would not be amiss in such cases, including that of our own monitors, to have a gun or two even lighter still, for in firing at an unarmored ship, or the unprotected ends of iron-clads of the Warrior or Bellerophon types, it is a waste of power—like taking a sledge to break an egg-shell—to use a 15-inch smooth-bore or a 12-inch rifle gun.

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for my belief. That you should hold the opposite opinion is quite natural. You cannot shake my conviction; I cannot shake yours; and I really cannot see what is to be gained by any further correspondence or discussion.

I have purposely avoided the subject of the relative resistance to shot of the several targets, it has no bearing on the question between yourself and the admiralty, though I am afraid that my conviction on this head would be found quite opposed to your own.

I remain, sir, your obedient servant,

ROBERT SPENCER ROBINSON.

[1] "The necessity for a better armor for our iron-clads is apparent from two indisputable facts: 1st. The 6½-ton gun, with the moderate charge of 16 pounds of powder, can send the Palliser shot of 115 pounds, broken up into ten thousand fragments, through the side of the Warrior at 500 yards. 2d. In a list of 30 of our iron-clads—about all we have afloat—20 are weaker than the Warrior in resistance to shot, five are equal, and four superior. Thus, 26 of our iron-plated ships can be penetrated by the 6½-ton gun with a very moderate charge of powder, and the remaining four would be pierced by the same gun and shot by increasing the charge to 22 pounds. If, then, every ship we have afloat can be penetrated by this comparatively light weapon, we can imagine the effect of the 12-ton gun, with 250 pounds chilled shot and 43 pounds charge; but no one can imagine the effects of the langridge of these terrible missiles between the decks of a crowded iron-clad, or contemplate the scene without a feeling of horror."—*Extract from a letter in The Standard.*

SCORPION AND OTHER IRON-CLADS.

In the same case is a model of the Scorpion, one of the *ci-devant* confederate rams. The Wyvern, the mate of this ship, is thus referred to in Admiral Yelverton's report:

"This vessel could never have been intended as a cruising or sea-going ship, for although she is buoyant and rises to the sea, yet from her being so very low in the water it rushes up her sides over all, and when broadside to the sea it is impossible to move about on her decks without the risk of being washed overboard. At sea she is almost always battened down, to the exclusion of air in the engine-room and stoke-hole."

R. Napier & Son, of Glasgow, show a model of the Osmanea, Azizea, and Orkhanea, frigates of 4,222 tons and 900 horse-power, built for the Turkish government. They are wholly armored with 4½-inch and 5-inch plates, on a backing of 9 inches of timber—armor quite incapable of enabling them to meet, and successfully cope with any ships of war, save such wooden vessels as attacked and destroyed the Turkish fleet at Sinope.

Another and more powerful ship commenced for Turkey, but which has passed into the hands of the Prussian government, is shown in model by the Thames Iron Works and Ship Building Company. This vessel is of 5,938 tons, and 1,150 horse-power. She somewhat resembles the Bellerophon frigate in the principle on which she is constructed, and has a protected forecastle carrying two guns.

A model of an iron-clad gunboat for Brazil, intended for service in the rivers of South America, is exhibited by Messrs. J. & G. Rennie, of London. Its length is 160 feet, tonnage 1,033 tons, and draught of water 9 feet 6 inches. There are two batteries, as shown in the following engraving, one fore and one aft, each battery being pierced for six guns, two on each side and two forward and aft, which enables the vessel to fight end-on, or with her broadside. The batteries are protected by 4½-inch plating, and there is a water-line belt of the same thickness. The sloping decks fore and aft are covered with 2½-inch plating. She has twin screws, and the bow and stern were fitted with temporary ends for the purpose of navigating the Atlantic.

MITCHELL'S MONITORS.

Along with several models of frigates and floating batteries Messrs. C. Mitchell & Co., of Newcaste, exhibit a model of two double-turreted iron-clads, which bear a closer resemblance to our monitors than any model in the Exhibition. The vessels represented by this model are the Rusalka and Charodaika, of 1,600 tons, and 300 horse-power, built for the Russian government. They carry two 300-pounders in each turret. These unpretending little craft cost comparatively little at first and are economical in commission. Low in the water, they offer an insignificant target to an enemy's gun. With their twin screws they are handy, compared with the three Turkish frigates built in Glasgow, and would

inly be more than a match for them in action, though each frigate at least, four times as much as the Russian monitor.

HALSTED'S TURRET SHIPS.

Mitchell's monitors the aim is to expose a minimum surface to the k of an enemy, but in the next, and last, collection which we shall to the very reverse is the case. We allude to the collection of ls exhibited by Admiral Halsted. These are undoubtedly the most ustive, the most complete, and perhaps the best finished models in uilding. This display is got up not only as a lesson to naval contors generally, but in the fond hope that the scheme of which it is xponent will be accepted as the most certain means of "maintainuture peace on the ocean by navies." This collection does not rept any constructed or even contemplated ship; it is a project, "pure imple," and certainly, if weighty and well-known names could insure ccess, it will not remain long without being realized. Among those iom Admiral Halsted tenders his acknowledgments for advice and sel we find the names of Scott Russell, Isaac Watts, C. B., late constructor of the British navy, and Oliver Lang, shipbuilders, Whitworth, Napier, and Penn have given valuable aid as engineers. lrawings were made by Mr. Henwood, and the models by R. Napier .; the turrets and tripod masts had the inspection of Captain Coles elf, while the armor, the gun-carriages, the boats and other fittings ie inventions of separate parties, the inventor of the boats being a yman of the Church of England. "In the multitude of counsellors is safety," but sometimes "too many cooks," etc.

ese models are eight in number, each representing a ship of war of ain "rate," and besides these there is a section in model, and various ls of gun-carriages, turrets, boats, &c. Admiral Halsted, as will en by the annexed woodcut of the "first rate," attaches little importto the twin screw system, or the triangular ram-prow so fashionat present. The balance rudder, flush with the water-line on even would, like that of the Bellerophon, offer a large target when the pitches moderately. The space included within the dotted lines in ngraving shows the extent of ship's side to be protected by armor. main-deck, with its battery of 14 guns, has no protection, but her these guns are intended for actual service, or merely for holiday nd practice, does not appear.[1] Referring to the spar-deck *a*, Admiral ted says: "It is acknowledged, in sincere obligation, that this most rtant feature in aid of the whole undertaking, is adopted from the iental spar-decks connecting turret with turret, in the American tors. And the expansion thus made, of the first idea thus given, re gratefully offered as a repayment to be applied, it is hoped, in oved comfort and security to America's own ocean turret fleet of the e."

have learned that these guns are to be used for practice, salutes, and operations on

The accompanying engraving of a half-hull section of these ships, which are all of the same character, will show the plan of construction proposed and the nature of their armor. This latter is to consist of a 6-inch plate (same as Bellerophon armor) resting upon a timber backing 11 inches deep; this, in turn, rests upon stringers of iron rolled in the fashion of the ordinary U-rail for railroads, 7 inches deep. The chief merit of the latter arrangement is that it presents a certain amount of iron edgewise to the blow, as in the Chalmers target. The most obvious defect of the backing adopted by Admiral Halsted is that the great weight of iron it contains offers no support to the armor-plate; thus any shell which can penetrate a 6-inch plate will explode in the 11-inch timber section, and the extra strength of the inner structure will enable the shell most effectually to blow off the armor-plate. The whole arrangement sets at defiance the oldest and best established military tactics. Here the first and second lines of defence, the plate and the U-rail backing, are united only by a plank of timber, and therefore the second line of defence gives little or no support to the first, leaving the structure to be destroyed in detail. The weight of materials in this structure is about the same as in the 8-inch Warrior target of which such fearful havoc was made by the Rodman gun, and which has even been penetrated by both shot and shell, from the 9-inch rifled gun.

Notwithstanding the many excellences of these models, the chief defect of the whole scheme consists in offering so large an unprotected surface to the fire of an enemy's gun. The main-deck battery, mounting in the "first-rate" 14 broadside guns, is 9 feet in height, all above the armored belt. "The sides of the main-deck," says Admiral Halsted, "are of ⅜-inch plates *unprotected*, the armor being limited to the vital body of the ships, and all connected with turrets. These sides are consequently liable to be riddled with shot-holes through which the water might afterwards flood the main-decks in heavy weather." Here the word "shot-holes" is used, evidently blinking the effects of *shell*, which have an ugly habit of bursting, and doing great damage between the decks of unarmored ships. The bursting of a few shells between the main and upper decks of these ships, tearing, up-ending, and setting fire to the planking of the latter, would be a serious obstacle to the training of the turret guns. It is not unreasonable to contemplate the flames communicating with the spar-deck and enveloping the turrets in a sheet of fire, which with the cloud of smoke would prevent any efficient working of their guns, and seriously interfere with the steering and handling of the ship, even if the fire did not entirely consume the vessel.

Again, a roll of 14 degrees would bring the main-deck port-sills within two feet of the water-line, and a shot striking her between wind and water in this position would, if a flat-headed steel shot, take the direction of the dotted line *a b*, (see woodcut,) passing, it might be, through amongst her turret machinery, and going out under the armored belt on the other side. None other but flat-ended steel shot or shell

likely to grip the $1\frac{1}{2}$-inch deck-plate at this angle, but this form ould be assisted in its work by the six-inch deck-planking of a ogival, round-headed, or spherical shell would glance along probably striking the turret machinery shield at C, and burst-rds through the ladder opening *d*, into the turret itself. Every ting on this main-deck would, doubtless, send a considerable e of its fragments through the capacious opening *d*, into the These ships, as well as those designed by the British Admiralty, entiful supply of crevices and vulnerable points, which their fondly expect will not be detected in action. We frankly admit of these chinks are such as no gunner would be able to take advantage of. But we have all read of the king who went secure, as he thought, in his panoply of mail, and that "a cer-drew his bow at a venture, and smote the king between the he harness."

rd more, and we will take our leave of this highly interesting dels and the ambitious[1] scheme which they have been designed ut.

angement, *en eschelon*, of seven turrets on the deck of one vessel ive of such confusion in the lines of fire, that some of Admiral best friends dread this more than even the shot of the enemy. fear the enemy's shot," says Mr. R. Napier in a letter to the 'so much as the risk of the shot from the turrets themselves aged against an enemy." The smoke of these turret guns between the upper and spar decks (independent of the results xploding on the main-deck) will undoubtedly lead to confu-aining the guns, and perhaps to the results so much feared by er.

ve not alluded to the armament of these proposed ships, or to ious gun-carriage of Captain Heathorn,[2] because we do not at the project (which has, doubtless, many good points) will me *un fait accompli*. To lower the turrets to the level of the (see cross section) and do away with the unarmored part r, would certainly improve them. To which changes may be substitution of twin for single screws, and an arrangement of

uch ships would more than suffice to realize the Mediterranean as a lake for ighbor; and close, in that direction, our intercourse with India. And four such as effectually close the intercourse between France and Algeria. How would of such a force guarantee peace for all such as frequent the sea upon their law-s."—*Halsted's Text Book.*

s-*pivoting gun-carriages of Captain Heathorn, R.A.*—These most valuable car-lopted for turret and broadside armaments throughout. They have great con-rit: 1. In the simplicity and small number of parts. 2. In their capability for d strength. 3. In their adaptability to all guns for all services; except boats, in would be needless. 4. In providing a minimum of port, with a maximum of nmand, vertical and horizontal. The parts, though simple and few, as well as , are the product of practical mathematical application."—*Admiral Halsted's*

the horizontal iron in the backing so as to support the armor-plate. These vessels in outward form would then bear a resemblance to our own Monitors, and be better engines of war; but then they would not be the realization of the dream of Admiral Halsted. We have not hitherto adverted to the tonnage of these ships, and only do so now to illustrate the dreamy nature of the entire project. The tonnage of the largest—the "first-rate"—is nearly equal to that of the Great Eastern, whose performances at sea hold out very little hopes of handiness to Admiral Halsted's customers. Two or three of the others exceed, by thousands of tons, the tonnage of the monster British iron-clads which have been universally condemned. The cost of one "first-rate" would be over $4,000,000, a sum sufficient to build and equip a dozen Monitors, with four 15-inch guns each, which with one salvo of shot, (23,520 pounds weight,) and the charges used at Shoeburyness, could easily sink the admiral's entire fleet. If it be desirable in iron-clad ships to combine a maximum of offensive power with a moderate cost and a minimum risk of danger, then Admiral Halsted and his coadjutors have certainly missed the mark.

Our Monitors, whatever be their shortcomings, have seen some rough work and have done the nation good service. The European iron-clad has not often "smelt powder," and the English, especially, has her spurs to win yet. The French floating batteries did some service at Kinburn. and the Danish, Austrian, Italian, and Spanish iron-clads have all been under fire. The British is still an experimental ship. We have endeavored to describe its characteristics and capabilities fairly and without prejudice. About 15 of Britain's iron-clads are wooden ships, and eight of the iron ships have sides of 15 to 18 inches thick only, including the wood backing. These, including the three largest ships in the navy, the Minotaur, Agincourt, and Northumberland, are among the initiated spoken of as the "Egg-shell-fleet," and in the event of a war would prove a source of weakness rather than of strength to the nation. The same may be said of at least half of the wooden ships. This state of affairs, evidently originating in the mistaken views of the admiralty's advisers with regard to resistance to shot, seems to be duly appreciated in England, and doubtless has of late years greatly influenced the national leaning towards non-intervention.

No one who examines the products of British skill and labor as illustrated on the Champ de Mars can doubt, for a moment, that English ship-yards can turn out iron-clads better adapted for naval warfare than any possessed by the British government. Indeed they have already furnished such ships for other countries. But whatever may be the skill of the British mechanic and his powers of forging and bending iron to his will, that skill and these powers, in government establishments, must be directed by men whose chief boast is that they knew nothing of the laws by which the mechanic is guided, just as their ancestors in the middle ages boasted of their inability to read and write.

CONCLUSION.

ı laying before the American government and people the results of ıree months' inspection of the munitions of war exhibited in Paris, wish to say that we have been guided, first, by a desire to place ›re our country the most correct information on all the subjects ;hed upon; and, secondly, to do justice to any article, invention, or gn that seemed deserving of attention. That we may have over- :ed some things really worthy of notice is not to be wondered at, con- ring the extent and variety of the collection, but we have not know- y slighted anything of real interest. Desirous only of giving the ; description of each exhibit as it came under consideration, we have iled ourselves of the labors of others, from time to time, and have nowledged the source of our information. If, however, any omission his nature has been made, through interruptions or otherwise, we re to disclaim any intention of having done so willingly, and once all tender our best thanks to those by whose labors we have been sted.

' a close study of the several branches of war materials herein dis- ›ed could enable us to give an opinion on the respective questions ; come under our notice, we may venture to say that our countrymen e little to learn, and nothing to fear, from European makers in the ter of small-arms. In light ordnance up to seven inches in calibre, the itworth guns, for range and accuracy, would doubtles take the first ›e among all those exhibited in Paris. But in heavy ordnance, as l as in the design and construction of iron-clads, the European nations "still at sea." The large rifle, in consequence of the erratic ricochet ts projectile, and its brief existence, is inferior as a naval gun to large ›oth-bores, and few, if any, European iron-clads could successfully age one of our monitors armed with 15-inch guns. The rifled guns :he Alabama, bore about the same proportion to the smooth-bore non of the Kearsarge, as the large-sized rifle guns of England and nce bear to our 15-inch cannon. The result of the combat between ›e two ships on the coast of France, and the power and endurance ly shown by the Rodman gun at Shoeburyness, if unheeded and nproved by the governments of France and England, cannot be to us ›use of regret. These events, while bearing testimony to the sound- s of the policy hitherto adopted in regard to such matters in the ited States, clearly indicate the path to be pursued in the future.

APPENDIX.

THE ROBERTS BREECH-LOADING RIFLE.

The Roberts system of breech-loading has been adapted hitherto chiefly to the Springfield pattern of gun. The barrel of the converted gun from the muzzle to the face of the breech-block is 37 inches in length, with a chamber of 1¼ inch. This chamber has a uniform taper throughout, the maximum diameter being sixty-four hundredths of an inch, and the minimum diameter fifty-eight hundredths. The following is an extract from the inventor's description of the breech-loading arrangements as applied to a muzzle-loading gun of the Springfield pattern:

"The breech-loading parts are five in number, and are made by hand, and screwed on to the rear end of the barrel. The first piece is a malleable iron breech-frame, that is screwed on to the rear of the barrel, and imbedded in the stock in the place of the old breech-pin. To effect this attachment, the rear of the old barrel is cut off about one inch in front of the cone, and a male screw reaching nearly to the rear sight of the barrel. The breech-plug is inserted through this frame, and supported against the rear on a semicircle concentric to the axis of motion. The centre of this semicircle is the prolongation of the axis of the barrel. The rear of the breech-plug is turned to fit with exactness this semicircle, and is played around it like a fulcrum. The chucks of the frame sustain the breech-plug laterally. When the breech-plug is in place in this breech-frame, it forms a curved lever, the handle projecting backward, and it then is moved about the solid concentric abutment of the frame, instead of being pivoted by any system of joints or pins, affording the greatest solidity and strength. The forward end of this breech-piece has a semicircular groove, cut transversely through it, for the purpose of receiving a corresponding tenon, formed on a block of steel, termed the recoil-plate. The front of this block is flat, so that when in position it fits squarely against the vertical face of the chamber, and the rear end of the cartridge shell. A small space is left between the tenon on the rear of this block and the front surface of the breech-block, above the traverse groove, to admit of a slight rocking motion of the recoil-plate, so that it will descend to expose the breech of the barrel, and admit the cartridge into the chamber; this small open space permits the recoil-plate to descend perpendicularly, when the rear of the lever is raised, until the top of the plate passes below the axis of the barrel, after which it swings with the arc of the circle on the rear end of the breech-frame. When the rear of the lever is brought down to its place, the recoil-plate ascends to its position by the exact reverse motion, up to the axis of the barrel on a circular motion, and afterwards to close the

chamber ascending vertically and closing squarely against the butt of the cartridge shell and the vertical face of the chamber.

"The firing-pin is located on the right side of the breech-block and the recoil-plate, directed to the centre, for centre-fire cartridges, and grooved into the sides for the rim-fire cartridges. It is so set in on a shoulder, that the force of the blow of the hammer cannot drive it a greater distance than is necessary to insure fire.

"The extractor is a curved lever fixed on the left side of the chamber, with one arm behing the flange of the cartridge, and the other operating in a vertical groove on the left side of the recoil-plate. When the lever is raised and the recoil-plate descends, the arm in the groove is not touched until the top of this plate reaches the bottom of the chamber; the shoulder at the upper end of the groove then strikes the lever and ejects the cartridge shell."

Instead of following the inventor's description further, we append the following extract from the report of the New York State board for the examination of breech-loading military small-arms:

"The guns presented for competition embraced the best systems invented, and the board is convinced that all practicable methods of breech-block movement have been already applied, and that future efforts in this direction must be confined to details or combination. Including both sessions of the board, 36 distinct systems have been tested and seven others examined, and as these have comprehended every general principle applied either in this country or abroad, the board feels confidence in expressing the opinion that no radical improvements over present systems are probable, and that future advance must be made in the direction of improved ammunition, or by a complete abandonment of present armaments and a substitution of entirely new weapons of warfare. Our own great recent war and the hostile complications in Europe have stimulated and directed in this channel the inventive skill of both continents, and thus produced a rapid development."

In the *resumé* of the five classes into which breech-loading arms are divided, the report, referring to guns of the 3d class (*i.e.*, with the breech-block, moving on a shoulder or pivot at its rear end, dropping in the receiver below the chamber, for insertion of cartridge,) says: "The only gun of this class presented at this session was the Roberts, which had been much improved since the previous session. The breech-block and appendages are readily removed without dismounting the entire piece, as hitherto, and a spring is applied to the firing-pin, retracting it when not pressed forward by the hammer. The lever should be further depressed so as to lie closer to the handle of the stock. The strength and safety of this arm, and its ease of manipulation and capabilities for rapid firing, are conceded by the entire board. The security of the breech-block as against accident by premature explosion, or the bursting of defective cartridge cases, is indubitable. The ejection of the empty cases is accomplished without springs, as the inclined position of the

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breech-block facilitates ejection. Original guns on this system, while embracing all the advantages of the converted gun as tested, would also be capable of other important improvements. Generally it may be expressed that guns of this class, from the peculiar system of the breech, are eminently safe and durable, capable of sufficient rapidity of fire, and the objection that they are not adapted to the central-fire system of cartridges is sufficiently answered by the successful tests."

The conclusions of the board in this case fully corroborate our own views of the relative merits of rim-fire and central-fire cartridges, as expressed in the body of our report when speaking of the breech-loading competitions in England. In regard to the Roberts gun the following resolution expresses the decision of the New York State board:

"*Resolved*, That after careful and long continued examination and experiments, and in consideration of the combined qualities of strength, durability, safety, efficiency and economy, this board deems the Roberts system of conversion of muzzle-loaders into breech-loaders as superior to all others examined, and recommends that the muzzle-loading arms of the State be converted to breech-loaders on the Roberts system."

THE BROUGHTON GUN.

This gun is the invention of Mr. John Broughton, of New York, and though not in the Exhibition, it was shown in model to ourselves and others in Paris during the summer of 1867. Its action seems to be the very perfection of mechanism, combining, as it were, the rapidity of a magazine gun with the security of a muzzle-loader; and yet the number of pieces or parts is not greater, but rather less than in the Remington and other breech-loaders of a similar class. There is, we believe, one spring more than is found in most American breech-loaders, but this spring is one which, in the opinion of experienced gun-makers, will outlast the gun itself, and is not liable to get out of order. Believing the Broughton gun to be entitled to the same consideration as we have given to other and similarly promising inventions, we shall as in other cases give the inventor's views of the principles embodied in his own words. He says: "In the construction of this rifle the following principles and considerations have been kept in view, and will be found embodied in the combination and arrangement of the mechanism:

"1st. A breech-block in its opening and closing motions should move longitudinally in the line of the axis of the barrel, either by sliding in a groove or by swinging on an axis; the swinging motion being preferable on account of its compactness and the ease with which it can be operated. All breech-blocks which open and close with a lateral motion either upward, downward, or sideways, require the cartridge in the act of loading to be pushed clear into the barrel by the finger or thumb of the operator before the breech-block can be closed. This is a serious defect, particularly when the fingers are cold and benumbed, or the cartridge is so large that it fits tight in the bore of the barrel, the cartridge also is

liable to become jammed by the sudden closing of the breech-block, and under any circumstances it is an operation necessarily slow, and one that requires a degree of attention not likely to be given to it under the excitement of rapid and continuous firing. The longitudinal swinging motion, on the contrary, merely requires the cartridge to be partially inserted in the bore of the barrel, after which the closing motion of the breech, operated by a powerful lever, forces it clear into its chamber with ease and rapidity, and without the slightest attention on the part of the operator.

"2d. A downward and forward motion of the hand in the line of the barrel to open, and a backward and upward motion in the same line to close, are the simplest, and most direct, and quickest motions that can be made in the opening and closing the breech mechanism of a gun.

"3d. The locking device, combined with a longitudinally moving breech-block, should be operated simultaneously with, and by the same motion that opens or closes the breech-block. Breech-blocks which move in the line of the barrel, but require a lateral or distinct motion to lock and unlock them, are defective from the fact that they require two unnecessary motions when the breech is open and in the act of loading; while the longitudinal motion to close the breech is easy and rapid, the lateral motion to lock it is both awkward and difficult, and under the excitement of continuous firing, this motion would be sometimes only partially made, in which case the breech would be but partially locked, and liable to be blown open when the gun was fired.

"4th. The combination and arrangement of the swinging breech-block, the locking device and the hammer, should be such that the hammer cannot fall and explode the cartridge without the breech-block being securely locked.

"5th. The arrangement of the breech-block, the locking device and the hammer, should be such that the breech-block cannot be opened and a cartridge inserted without the opening motion serving to put back the hammer to the safety position or half-cock, at which position it should be left when the breech closes.

"6th. The arrangement of the breech-block and the locking device should be such that when acted upon by the explosion the recoil will tend to lock them more firmly together.

"7th. The arrangement of the locking device and the hammer should be such that while the hammer in its fall will force the locking-brace to enter its proper position (provided it has not already done so) before the cartridge can be fired, yet when the breech-block is closed and locked, it should remain securely locked independent of the hammer, thus enabling the hammer to be moved by the thumb to any position, irrespective of the locking of the breech, and merely requiring it to perform the ordinary function of firing the cartridge.

"8th. The arrangement of the mechanism to be operated by the thumb or finger in the act of opening or closing the breech should be such as

to be capable of easy and rapid manipulation. A slight pressure of the thumb, applied to the operating lever of this gun, exerts a considerable and ample force to unlock and open the breech and withdraw a tightly expanded, cartridge-shell from the bore of the barrel. This is accomplished, too, with a range of motion to the lever, which leaves it within easy reach of the fingers when grasped with the thumb resting on the top of the stock for the closing motion.

"9th. An extractor, to be perfect in its operation, should take a broad and firm hold of the rim of the cartridge-shell and move longitudinally in the direct line of the barrel, so as to be in contact with the rim of the shell during the entire motion of the extractor, and compel a tightly expanded shell to be withdrawn without the possibility of slipping or cutting through the rim. Its motion when the breech is fully open should be suddenly accelerated, so as to throw the exploded shell clear out, without the necessity of elevating the muzzle of the gun or requiring the shell to be picked out with the finger and thumb.

"10th. Similarity of action or motion in all the moving parts, and all moving in the same plane or direction, is conducive to ease and rapidity of operation. The distinguishing features of the entire breech mechanism of this gun consists in its being arranged and constructed to operate on the principle of rotation, by which means the parts in the act of opening the breech all vibrate in unison together with a smooth and easy motion; thus the advantages of simplicity, strength, compactness, ease, and rapidity of operation are obtained and combined to the fullest extent, and the fewest possible motions are made in the act of loading and firing. When the breech is closed no opening is presented on the exterior surface, (even when the hammer is at full cock,) into which dust and dirt can enter to clog the mechanism. The parts themselves are few in number, and while they are comparatively light they are all substantial and strong, not liable to wear or break by ordinary use, and the entire fire-arm is plain and symmetrical in appearance."

The inventor gives what appear to be cogent reasons in favor of each of the principles here laid down, and illustrates their value by arguments drawn from the defects of other systems of breech-loading. Into these controversial points we have no desire to enter, and shall conclude our notice of this new weapon by quoting the inventor's descriptions of the movements necessary in loading and firing:

"In loading and firing the movements are as follows: Supposing the gun to have been loaded and the first shot fired, and the operation to be continued as rapidly as possible, then full cock the hammer with the thumb, while lowering the gun from the shoulder to the loading position. Pass the thumb from the hammer down into the rear loop of the lever, and swing it quickly forward to open the breech and extract the shell. Push in a cartridge until it comes in contact with the extractor; close the breech by a squeezing action, the thumb being on top of the stock and the fingers extended down in front of the lever. Raise the gun and

fire. The raising of the gun and closing of the breech may be simultaneous.

"If the gun is intended to be loaded and not fired immediately, the hammer need not be moved with the thumb. The motion of the operating lever in the act of opening the breech will half-cock the hammer, and when the cartridge is inserted and the breech closed, it will be left at its safety position.

"The motions in loading and firing being of the character termed 'easy and natural,' a very little practice makes the action of lowering the gun from the shoulder, cocking the hammer, and opening the breech, approximate very closely to a single and continuous movement. So also the action of closing the breech, raising the gun and firing; hence for rapidity in loading and firing, this gun is not excelled (if equalled) by any other single-loader."

THE GATLING BATTERY.

The inventor of this weapon, referring to the guns tested in France and England during 1867, says: "I wish to state that the Gatling battery guns of six barrels exhibited in the Paris Exhibition, and tried at Versailles, as well as these used in the trial at Shoeburyness and at Fortress Monroe, have, together with the ammunition, been greatly improved since these trials were made. Improved Gatling guns of one-inch calibre, with 10 barrels, are now being constructed at Colt's armory in Hartford, which can be fired at the rate of 200 rounds per minute. These guns discharge half-pound solid lead balls, and have an effective range of 2,500 metres, or say, one and a half English miles. Another class of the same weapons, also with 10 barrels and of half-inch calibre, are now making at the same armory; these have been fired at the rate of over 300 shots per minute. The trials of the Gatling gun at Shoeburyness were made under the most unfavorable conditions. The gun used on that occasion was very imperfect both in material and workmanship, the firing-pins were made of hard steel, and one of them was broken before the commencement of the trial. Thus the gun was tested in a disabled condition against an Armstrong gun, and that, too, by men who were unacquainted with its use, and who were quite familiar with the Armstrong. The ammunition was also very defective. Two of the six-barrel and one of the 10-barrel improved guns, with new ammunition, have been tried lately at the target grounds at Versailles. At one of these trials the Emperor attended, accompanied by the minister of war and several distinguished officers of the French army. On this occasion the president of the artillery commission reported that "The service of the 1-inch gun was excellent at 2,400 metres, and indeed exceeded his expectations."

PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

ON

INSTRUMENTS AND APPARATUS OF MEDICINE,

SURGERY AND HYGIENE;

SURGICAL DENTISTRY AND THE MATERIALS WHICH IT EMPLOYS; ANATOMICAL PREPARATIONS; AMBULANCE TENTS AND CARRIAGES, AND MILITARY SANITARY INSTITUTIONS IN EUROPE;

BY

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UNITED STATES COMMISSIONER.

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PART I.

DICAL AND SURGICAL INSTRUMENTS AND APPARATUS

L REMARKS—SURGICAL INSTRUMENTS—APPARATUS FOR PUPLIC AND PRIVATE NE—ARTIFICIAL LIMBS, ORTHOPEDY—ARTIFICIAL EYES—BANDAGES—ANATOMI- REPARATIONS.

INTRODUCTION.

productions comprised in Class 11, which form the object of this are very varied in their character, and constitute a complex and ınt branch of industry. They consist of the numerous apparatus ıtruments which are used in the practice of medicine and of civil litary surgery, artificial eyes, legs, and other apparatus pertaining prothesis of limbs, anatomical preparations, and also a series ɜts tending to the promotion of public and private hygiene, such various implements and accessories of gymnastic exercises, of ıerapy, and of ventilation.

fabrication of these instruments and apparatus forms in the pres- a branch of industry in which thousands of workmen are occu- The chief centres of the manufacture are in Europe—the cities of London, Berlin, Vienna and Bologna, and in the United States, 'ork and Philadelphia. The materials principally employed in ınufacture are steel, iron, copper, tin, zinc, and also gold, silver, ıminum. Certain products of the animal and vegetable kingdom) indispensable, principally woods of various kinds, different gums, ıouc to a large extent, horn, skins and ivory.

SURGICAL INSTRUMENTS.

ınstruments designed for the use of civil and military surgeons are ed as the operations for which they are required. Special instru- ıre used for the diminution and rectification of natural deform- ır the extraction of foreign substances from the body, and for gical examination of the organs.. Other instruments are employed ɔutation; others for operations on the external parts; and others vhere the internal organs are to be operated upon.

Exposition of the Champ de Mars displays a most complete col- of surgical instruments, and among them may be found some very ıus specimens, which are worthy of being pointed out to the atten- the medical profession. Although the majority of the European have furnished samples of this branch of industry, not one of vho have exhibited can dispute with France the palm for variety,

number and finished workmanship of the instruments. It is to be regretted that England, whose surgical instruments deservedly enjoy so high a reputation, is not represented by a single collection.

Among the French exhibitors the firms which claim notice in the first rank are the celebrated establishment of M. Charrière and that of M. Mathieu. Both have, on this occasion, again vindicated their former superiority by the assemblage of new and ingenious instruments which they have submitted to the appreciation of the public. Some of these instruments have been designed by the manufacturers themselves; others by surgeons of this capital, [Paris;] but all, without distinction, are executed with extreme care.

First-class materials are employed in every instance, and the finish of the work rarely leaves anything to be desired. It does not fall within the scope of this report to enumerate all the instruments shown in the cases of these two firms which commend themselves to the notice of the surgeon, but we may specify the new forceps and lithotritic instrument of M. Mathieu, which permits of the prehension and retention of calculi of the largest size, although they may be introduced into the bladder by an incision of the dimension of three centimetres at the utmost. We will also remark the excellent trocars, both probing and exhaustive, of the same firm, which facilitate operations on superficial tumors, and the special trocars for the operation of ovariotomy. The firm of Charrière, (now Robert and Collin,) which enjoys a great reputation on the European continent, exhibits a series of instruments peculiar to themselves. Their improved tenacula and sounding instruments are of the most practical character. Their instrument cases are compact, moderate in price, and contain a large number of well-assorted instruments. Their apparatus for the extraction of foreign bodies from bones deserve special attention. Some of them have been advantageously used in the removal of projectiles. One of these instruments, as remarkable for its simplicity as for its ingenuity, was successfully employed in the special case of a fragment of a ramrod, or sword blade, remaining embedded in the bony parts. The trephines exhibited by Charrière are very varied, and are chiefly noticeable for the happily ingenious modification of the screw, the teeth of which resemble those of a saw. The instruments for resection and amputation, especially the saws and tourniquets shown in this case, likewise display some ingenious improvements. The saw with a blade capable of being turned in all directions, and firmly arrested in any position, invented by M. Charrière, possesses great advantages, as it can be used in subcutaneous resections.

Another Parisian exhibitor, M. Galante, has distinguished himself by his extensive and intelligent employment of vulcanized caoutchouc in this department of French industry. He displays a fine collection of useful and ingenious instruments, in the manufacture of which this substance is advantageously substituted for webbing, wood, ivory and metals hitherto used for this purpose. Some of these numerous instruments are incontestably superior to the old apparatus they are designed to

replace. Such, for instance, is a small instrument adopted for the extraction of foreign substances from the nasal cavity. For this purpose, pincers or a blunt hook are generally applied, and in serious cases Belloc's sound is employed covered with a pellet of lint. But this instrument, the use of which is difficult to the operator and painful to the patient, rarely succeeds, and frequently produces vomiting. The caoutchouc tube and pellet invented by M. Galante is easily introduced, and being compressible it assumes, as it enters, the form of the cavity, and causes no pain to the patient. The pessaries of vulcanized caoutchouc, constructed by the same exhibitor, must be ranked among the most useful surgical apparatus, and constitute a great advance upon the older instruments of this class. They are compressible between the fingers and assume an elongated form, which facilitates their introduction, and when entirely introduced they expand and adapt themselves perfectly to the parts they are intended to support. I confine myself to these notices, although it would be easy to point out a number of other articles in the show-case of this exhibitor, all of which bear irrefutable testimony to the great importance which vulcanized caoutchouc has attained in the manufacture of surgical instruments and apparatus. Herr Leiter, of Vienna, has also employed this substance for the same purposes, and with much intelligence. His instruments are solid, light, and free from liability to deterioration; and are, notwithstanding, much cheaper than the same instruments would be if constructed in metal.

One example will suffice to substantiate this assertion:

Pravaz's syringe in metal costs from 20 to 25 francs; while the same instrument in vulcanized caoutchouc can be delivered to the trade at 8 or even at 7 francs. The same maker's winch-pump, with caoutchouc tube, is based on a remarkably simple principle.

His cases of instruments for operations on the eyes and ears and for amputations are well arranged, and his model of a resection saw with lever handle is commendable for the facility with which the blade can be extended.

M. Luer, of Paris, exhibits a collection remarkable for its richness, variety and beauty. An ingenious instrument in this case attracts attention: It is a sound for probing gunshot wounds, with an electric bell which strikes as soon as the probe touches the metal projectile. If the firm of M. Luer vies with the largest and oldest houses of Paris in the high finish of its productions, it is not inferior in the zeal and care displayed in maintaining itself on a level with the latest American and European inventions in its class. This firm excels in the instruments employed in dental surgery, and with a view to improvement its head has resided for some time in the United States for the purpose of studying this specialty. In the Italian gallery Mr. Lollin exhibits some fine instruments, among which an excellent forceps may be prominently noticed. Mr. Nytrop, of Denmark, sends some very noteworthy herniary bandages; and Mr. Pischel, of Prussia, a number of carefully constructed instru-

ments, principally those employed in the galvano-caustic process. In the American gallery the instruments of Mr. Tieman, of New York, exhibited by Mr. Barnes, Surgeon-General of the Army of the United States, are distinguished by their variety and their approved utility. It is to be regretted that this branch of industry, which has attained so high a pitch of development in the United States, is not more fully represented. There is, however, in the United States gallery a splendid collection of instruments specially designed for the use of dentists, to which I have referred in my report on dental surgery.

APPARATUS FOR PUBLIC AND PRIVATE HYGIENE.

The different objects that are treated of in this paper belong, if not to the domain of medicine, at least to that of hygiene, which is closely allied to it. In the first rank of these articles I will notice the bath apparatus and the therapeutic instruments which have rendered so much service to the lower classes. France is the most creditably represented country for this class of industry in the whole Exhibition. The firm of G. Charles, of Paris, has exhibited a fine collection of baths, with very ingenious apparatus for heating them, and their shower baths and *douches* for the spinal column are very practical. Bouvillon, Muller & Co. have likewise a very complete show of hydrotherapic apparatus. Their hip-baths, with which any kind of *douche* can be administered, are particularly noticeable.

The firm of Mathieu has constructed an elegant table supplied with a number of jets in such a manner that several persons can separately but simultaneously inhale one of them, the liquid being sprayed, and saturating the air of the apartment. M. Lefebvre, of Paris, has designed an ingenious portable apparatus for vapor baths and the fumigation of beds without damping.

The gymnastic apparatus are rare but they are very remarkable, and we may cite those sent by Messieurs Burlot & Vian, of Paris, Mr. Rein, of London, and particularly that sent by Prince Oscar of Sweden.

Among the hygienic apparatus the excellent systems of ventilation in the machine gallery must be mentioned, and above all the ventilator of the Palace itself is very interesting and remarkable, as applied to the aeration of large public establishments. Subterranean passages branch all through the ground on which the Palace is constructed and converge to the centre, and the air passes into the galleries through a number of wooden gratings. This system, devised by M. de Mondeser, is based on the principle that when a stream of air is thrown with great speed into a tube open at both extremities, it produces a slow movement of the whole column of air contained in the tube. The air is introduced through large circular apertures, covered with iron gratings, by blowing machines worked by steam. Before each aperture streams of water are disposed and, carried forward by the current of air they turn into spray, spread about the inside of the pipes and cool the interior space.

ARTIFICIAL LIMBS, ARTIFICIAL EYES, AND BANDAGES.

In examining the galleries devoted to the instruments and apparatus treated of in this report, the observer is especially struck by the considerable progress that has been made of late years in artificial limbs, both in respect to their natural form and the excellence of their manufacture. The advantages which have been rendered to this class of industry by the application of caoutchouc may here be particularly noted, and it is my conviction that future improvements will be based principally on the application and use of new materials. Orthopedic apparatus, and especially artificial limbs, are very numerous at the Exposition of the Champ de Mars. The firm of Mathieu, of Paris, exhibits excellent artificial arms, one in particular, similar to that constructed by them for the eminent singer Mr. Roger, whose forearm had been amputated. With the resources at present at the disposal of science, it would be difficult to make a more complete and more ingenious article of this kind. The tractions are so well combined with the movements of the shoulder and of the body that the artificial forearm may be bent back to the shoulder, over the chest, and can be moved backwards, and over the head. The fingers and the palm move with facility. The extreme lightness of this apparatus has been attained by the combination of aluminum and steel with the lightest wood.

The artificial arms exhibited by the firm of Robert and Collin are light and well articulated. Their apparatus employed in dislocations of the hip allows the patient to sit down without inconvenience or pain.

In the English section the collection shown by Mr. Masters, of London, commands attention by its display of crutches of extreme lightness, and artificial limbs which vie with the most perfect productions of French manufacture.

I would also call the attention of practitioners to the artificial hand, constructed by Mr. Masters, with which a pen, playing cards, &c., may be held This manufacturer also exhibits a table-service of great ingenuity, and well adapted for artificial hands.

An artificial foot, made of cork, for elevating a short leg, is a striking object in the show-case of Mr. Norman, of London.

Mr. Leiter, of Vienna, exhibits an excellent apparatus in hardened caoutchouc for club foot.

The artificial arms made by Messrs. Selpho & Sons, of New York, rank among the best productions of this class. They possess the quality of extreme lightness, and are of superior finish.

The artificial legs made by Mr. Marks, likewise of New York, are distinguished by similar qualities; they are carefully made, light, and well articulated.

In the collection of the American societies for the relief of the wounded we find some artificial legs, constructed by Dr. Hudson, of New York,

which are perhaps the most successful in the whole Exhibition. In the same class Count Beaumont exhibits some artificial limbs, the extreme lightness of which, and their cheapness, must commend them to public notice.

The construction of artificial eyes has been much developed of late years, and in Paris, especially, vast progress has been made.

Those exhibited by the manufacturers of the French metropolis, and particularly those shown by M. Coulomb Boissonneau, are distinguished by the excellence of their color, which approaches closely to the natural tints. Another Parisian manufacturer displays a curious collection of artificial eyes of both men and animals; and M. Boissonneau, jr., sends a collection which possesses high scientific interest. This collection represents the various pathological conditions of the cornea, the iris, and the crystaline fluid.

While the construction of artificial eyes has been thus improved, we must also in justice add that, on the other hand, the fabrication of instruments, specially adapted to the surgical examination and treatment of the eye, has made great advances in the hands of certain specialists, thanks being due to the intelligence of the instrument makers. MM. Mathieu, Galande, Luer, Collin & Robert, of Paris, and M. Stille, of Stockholm, who exhibit many pieces of apparatus of this description, particularly M. Stille, who has, in the Exposition of the Champ de Mars, brilliantly maintained his high reputation.

The majority of the exhibitors of surgical instruments have distinguished themselves by their designs for bandages, which are occasionally of great excellence. Some of these pieces of apparatus are intended to convey a supplementary aid to surgical operations; others—such as waist belts, stockings—to sustain feeble or defective parts of the body. Others again must be considered as appertaining rather to the domain of hygiene than to that of medicine or surgery. In this paper, however, we shall not discuss them separately.

The herniary and compressory bandages exhibited by M. Charbonnier, of Paris, possess great flexibility. M. Galante has constructed abdominal belts and elastic stockings which may be recommended to the notice of the medical profession.

The apparatus and bandages of M. Le Perdriel, of Paris, are justly held in high estimation. They compress and sustain the limb affected, without any exaggeration of the pressure.

The herniary trusses and bandages shown in the Italian gallery are very light and exhibit great ingenuity in their construction. The chest protectors of Mr. Marsden, of London, merit notice for their strength and the good quality of their material.

Other French and foreign exhibitors have also signalized themselves in this branch of manufacture; but to enumerate them would be to convert this report into a lengthy catalogue.

ANATOMICAL PREPARATIONS.

It would be, I think, superfluous to mention here the great importance that should be attached to anatomical preparations in the medical profession and in the general study of the natural sciences; but I may say that very few branches of industry require such a profound knowledge of the chemical properties of substances as this, or call for more care, delicacy and precision of manipulation.

Although anatomy is somewhat scantily represented at the Champ de Mars, the specimens are highly creditable and of an incontestable importance, and I question if there are among the whole range of exhibited objects any more worthy of the attention of medical men. Methods of preservation unknown up to the present time can here be seen, and all the pieces are executed in a remarkably perfect manner.

The preparations of Dr. Brunetti, of Padua, must rank the highest in their class for their novelty and the excellence of the process employed. His invention is quite novel, and I think is destined to produce a great influence on the study, or rather the teaching, of anatomy. It is to be regretted, on account of the importance of the invention, that this method of preservation is not yet known to the public. Thanks to it, the membranous linings can be made stiff to such a degree as to keep the primitive form intact. The color of the pieces exhibited is of a light gray, and on account of their rigidness they can be cut up into thin slices with more facility than any others prepared by a different method. They are remarkably light, quite inodorous, and, according to the inventor's word, remain incorruptible. The small branches of the arteries, the ducts of the gland, the digestive mucous membrane, and, in general, the most delicate and even microscopic organic parts, are perfectly visible.

In Dr. Brunetti's collection the pieces showing the kidney in its normal and its pathologic state are specially remarkable, for with the aid of an ordinary magnifying glass the most slender corpuscules of the cortical substance can be easily distinguished.

The anatomical preparations exhibited by Professor Hyrtl, of Vienna, are as remarkable as those of the Italian professor, but from quite a different point of view. If the manner of preparing them is not entirely new, they are at least prepared with an astonishing skill, parts generally considered inaccessible to the scalpel being beautifully dissected. These pieces are quite worthy of the great reputation of their author. The labyrinths of the ear of different mammiferous animals exhibited by Mr. Hyrtl are some of the most curious and difficult things the anatomist can prepare.

Mr. Teichman, of Cracovia, has exhibited a remarkable collection of mammiferous skulls which call for special attention, from the exactitude and perfection of their getting up. In the same case is found a curious collection of the olfactory organs, the preparation of which must have required an immense amount of labor and care. Mr. Tiechman has also

succeeded in injecting into the lymphatic vessels a substance that is capable of hardening, instead of the mercury generally used.

The French exhibitors show some fine wax-models. M. Talrich's collection is very fine, and there is a handsome model, by him, of the spinal cord. M. Vasseur's collection is likewise admirable, and includes a large sympathetic nerve and spinal column, very delicately prepared. M. Auzoux, the indefatigable popularizer of anatomy in France, shows some fine pieces of comparative and clastic anatomy.

PART II.

DENTAL SURGERY AND THE MATERIAL WHICH IT EMPLOYS.

ANTIQUITY OF DENTAL SURGERY—DENTAL COLLEGES AND SOCIETIES—DENTAL APPARATUS AND MATERIALS—ARTIFICIAL TEETH—DENTAL INSTRUMENTS AND GOLD FOIL—VULCANIZED CAOUTCHOUC, USE OF IN DENTAL SURGERY—ARTIFICIAL PALATES AND SETS OF TEETH—ANESTHETIC APPARATUS.

RISE AND PROGRESS OF DENTAL SURGERY.

Few branches of science have offered in their developments a more curious and instructive spectacle than that presented by the history of dentistry.

While its origin may be traced to the most remote epochs, it must be admitted, however, that it remained stationary for ages, and it may even be added that it has only become a real science within modern times, when an interest was first manifested in gathering together its scattered traditions and in connecting buccal operations with other medical and surgical studies, particularly with physiology and anatomy.

Four centuries before the Christian era, Hippocrates, relying upon experiments made long before his epoch, recommends the use of artificial teeth, and even teaches the manner of fastening them by means of wire. Observations of the same kind may be seen in other ancient authors. In Egyptian tombs mummies have been found whose hollow teeth had been filled by an operation analogous to that employed at the present time; it is proper to remark, however, that it would be difficult to determine whether this operation had been performed during the lifetime of the individual or after death, at the time of embalming the body.

Until towards the close of the 18th century artificial teeth were made solely of ivory or the teeth of the hippopotamus; but, in 1794, a French chemist conceived the idea of manufacturing them of porcelain, and succeeded in producing some which were light and of a tolerably suitable grayish tint. From the time of this invention the dental profession made remarkable progress in France, Germany, and England.

A short time after the American Revolution, two practitioners, one an Englishman and the other a Frenchman, Robert Woofendale and Dr. Gardette, went to establish themselves in the young republic of the United States. The former settled at New York, and the latter, Dr. Gardette, at Philadelphia. These two men were the initiators or introducers of dental science and art in America, where it was destined to occupy an important position and to make rapid and decisive progress.

At the close of the last century Dr. Hudson of Philadelphia substituted, for filling hollow teeth, gold leaf instead of lead used previously.

Indeed, it may be said without fear of contradiction that the United States is the centre from which the modern progressive movement of dental surgery starts.

The facts which I am going to report will sustain, I think, this assertion, by proving that, for 30 years past, numerous and intelligent efforts have been made to promote and maintain that scientific character and training which the profession of dentistry requires.

For this purpose several special schools of dental surgery were founded, where those who intended adopting the profession received methodical instruction. The first school of this kind was established at Baltimore in 1840, and was legally authorized to deliver diplomas of competency to those who should follow the courses and undergo the required examinations. Since that period five other institutions of the same character have been founded in different States of the Union. The one in New York is the most recent. This school, founded with the authority and by order of the legislature of the State, in 1866, is to-day entirely organized and highly prosperous. Distinguished and talented professors occupy its chairs, and teach dental histology and surgery, comparative and descriptive anatomy, pathology, therapeutics, chemistry, metallurgy, as well as dental mechanism.

This young faculty is already rivalling those of Baltimore and Philadelphia. The professors in all these schools are dentists, excepting only the professors of chemistry and anatomy in two of them. Physiology, anatomy, materia medica, chemistry, therapeutics, and more especially the physiology of the mouth, and buccal surgery, together with dental mechanism and metallurgy, are taught in the annual courses of these institutions. Like those of the faculties of medicine, the pupils of the New York faculty receive clinical lessons in the hospitals, so that the diploma of surgeon dentist delivered by this college has a value similar to one coming from the faculties of medicine, and the consequence is that most of the graduates of the school of dental surgery obtain at the same time the diploma of medicine.

Independently of these special schools, there exist in the United States numerous societies of dentists; such as the Association of Brooklyn, the Odontographic Society of Pennsylvania, the American Society, that of the Surgeon Dentists of New York, of Pennsylvania, of Michigan Valley, of Philadelphia, and several others.

A great emulation prevails among these associations, and constant and mutual communication contributes powerfully to promote the progress of the science to which they owe their origin.

Outside of the United States no special schools of dental surgery exist. In England, however, a lively interest is awakened to the necessity of establishing institutions similar to the American schools; and lately a *fortunate* move has been made in this direction. In 1858, a dental hos-

pital was founded in London, which, since that time, has rendered good services, thanks to the zeal of the practitioners connected with it. Although the founders have had especially in view the blessings which such an establishment must offer to the indigent classes, unable to incur the expenses necessitated by ordinary dental operations, the hospital of London approximates in its organization to the American schools of dental surgery in this sense, that those who are destined for the profession find there a vast field for investigation, and can readily avail themselves of the clinical courses which have been instituted for their benefit.

Besides this establishment there are two associations of dentists in England, whose works are remarkable for their variety and solidity.

The Royal Academy of Surgeons of Great Britain, actuated by the laudable desire of maintaining the dignity of the profession of dentistry, does not accord the diploma of surgeon dentist to any except those who, by examination, can prove their claim thereto, after having followed regular courses in schools recognized by the academy, particularly the courses of anatomy, physiology, therapeutics, chemistry, surgery, materia medica, and clinics in one of the hospitals of Great Britain.

In Germany, we find among the dentists a scientific ardor and emulation, particularly in the Society of Dentists of Vienna.

In England, in the United States, in France and Germany, journals and reviews, specially devoted to dental science, are regularly published, so that the practitioner can constantly keep himself *au courant* with the progress of his art and of the collateral sciences.

The succinct account which I have now made of the present condition of dental surgery and of the astonishing progress which has been realized in the last 30 years, will suffice, I think, to show its practical importance. Buccal operations, which are daily made in the great cities, such as London, Paris, New York, Vienna, Berlin, and Philadelphia, may be counted by thousands. For instance, in the Hospital of Dental Surgery at London, of which I have spoken, more than 78,000 operations have been performed. In New York and Philadelphia alone more than 1,000 workmen are occupied in fabricating different objects destined for the use of the surgeon dentist. It may be readily imagined that a science so generally applied must give birth to numerous trades. The practitioner needs a large and varied number of instruments; he applies sometimes to the chemist, sometimes to the druggist, oftener still to the metallurgists and manufacturers of instruments. He employs gold, platinum, lead, silver, and also, according to circumstances, aluminium, copper, iron, zinc, and tin; all these metals either in their pure state or in different compositions. For his instruments, he makes use the most often of the finest steel; he needs also ivory, porcelain, caoutchouc, gums, acids, perfumes, gases, and chemical preparations. All this gives place to transactions, often considerable, and whose results were necessarily felt at the Exposition of the Champ de Mars, where the products of all human trades were offered to the consideration of the world.

DENTAL APPARATUS AND MATERIAL.

Having been a member of the international jury for Class 11, I propose in the present report to call attention particularly to the part of this class devoted to the exhibition of different objects and apparatus belonging to dental surgery.

This special branch of the Exhibition of the Champ de Mars demanded on my part an examination the more thorough since the investigation was to show me the truth or falsity of a principle which I hitherto had considered just. Here is the question which I proposed to myself, and which I now answer negatively: Can or should the surgeon dentist exhibit as an artist or a manufacturer? When the manufacturer exhibits the product of his trade, when the artisan exposes what he has formed with his hand, when the artist exhibits the picture which he has painted, the statue that he has sculptured, they all present to the appreciation of the public things whose merits may be determined, objects which in themselves demonstrate clearly the skill, intelligence, the talent or genius of their authors. But what can the dentist exhibit to the public, to show in an incontestable manner, the superiority of his operations? Does not the dentist who exhibits find himself in exactly the same position as the surgeon who would pretend to prove his professional superiority by exposing the leg which he had amputated by the side of an artificial one which he had furnished to the patient? Even should a dentist exhibit an artificial piece, whose every part was of the most perfect workmanship, and which had been constructed of the most advantageous materials, would this piece prove anything more than the skill of the workman who had executed it, and the taste of the dentist who had ordered it? That which it is essential for the public to know, and which can alone show the merit of the exhibitor, remains unknown: what it is necessary to know in reality is, whether the apparatus has ever been fitted to the mouth of a patient, and, if so, whether the patient found it satisfactory. I might say the same of all the other objects of a surgical nature exhibited by the dentist, for it is not enough to expose *mâchoires* in plaster, furnished with artificial teeth, or indicating operations more or less astonishing; it would be necessary, before pronouncing upon the merits of the operator, to examine the patient himself upon whom these pretended operations were performed, and it would be particularly essential to know the final result of these operations.

If, upon the European continent, most practitioners have decided to exhibit artificial pieces and specimens of their operations, it is not the case with English and American dentists. We rarely see them figure among exhibitors, and in the present exhibition we find but a few isolated names of American and English dentists.

What is the reason of this singular contrast, to be observed between the practitioners of the continent and those of England and the United

States? Why have the dentists of the latter countries admitted the principle of the impropriety of exhibiting, while the practitioners of the continent seem to seek with eagerness every occasion to make a public display of their different products and artificial pieces? I think the reserve of the English and American dentists may be attributed to the influence exercised upon them by the instruction which they receive in the special schools of dental surgery; schools where the sentiment of the value and dignity of their profession has been inculcated.

Nevertheless, as much as I believe the principle, that dentists should not appear among the exhibitors, to be well-founded and just, I find it quite right that those who produce the material employed in dental surgery should expose their products. These are objects which bear evidence of their proper value, without its being necessary to resort to other researches in order to appreciate them.

But since dentists have exhibited at the Champ de Mars, I shall conform to the established custom by examining, in this report, the objects which they have displayed, after I have passed in review the much more important exhibition by the producers of dental material.

ARTIFICIAL TEETH.

Among the most indispensable objects for the surgeon dentist, artificial teeth take the first and foremost rank. To produce or manufacture good teeth is an undertaking much more difficult than is commonly supposed. On the one hand it is necessary that, by the choice of the substances employed in the manufacture, the teeth should be of sufficient solidity; and on the other, it is necessary that, by their form, their transparency and color, they should offer a living resemblance to the natural teeth. They must also be light, must resist the variations of temperature caused by the heat to which they must be exposed, and be so arranged as to adapt themselves easily to the different conformations of the maxillaries. To thus combine grace and beauty with solidity and durability is a problem which but few manufacturers have known how to solve.

Therefore, practitioners have, up to a recent period, willingly inserted, on account of their form, lightness, and color, human and animal teeth in place of those that were missing; but the high price of such teeth, and also the facility with which they decompose, together with the fetid odor which they engender, have caused their abandonment in favor of incorruptible artificial teeth. Teeth have been made of the tusks of the elephant and the teeth of the hippopotamus; but as these also deteriorate easily, the preference is now given to mineral teeth, when they are light, solid, and well tinted. Of all the mineral teeth so far invented, those of porcelain are the only ones that combine these qualities. These artificial teeth are composed of two distinct parts—the base and the enamel. The base is composed principally of feldspar, quartz, and kaolin, and the enamel is a composition of feldspar with some quartz.

[library stamp]

The quartz used in the fabrication of teeth is first heated to a white heat, then plunged into cold water, and lastly, reduced by grinding to an impalpable powder.

The feldspar which American manufacturers employ in preference is a very white variety, and is found in abundance at New Bedford, and in the environs of Philadelphia. Like the quartz, it is first exposed to a high temperature and then dipped in cold water; after which it is broken in pieces as regular as possible. It is then separated from foreign substances, and the pieces are reduced to powder in a mortar, or, still better, in a mill. This powder is very fusible, and when baked with quartz or kaolin infiltrates itself as a subtile paste into the mass and renders it translucent. The kaolin used in the manufacture of teeth is first carefully washed; after the coarser part has settled on the bottom of the vessel, the water charged with the finer part is poured into another vessel, to be left there until all the kaolin is deposited, and then the water is thrown off and the precious dust is dried in the sun. Sometimes certain varieties of clay, such as that found in the neighborhood of Baltimore, are advantageously employed as substitutes for kaolin. In preparing the paste, particularly that destined for the enamel, care must be taken that parcels of injurious dust are not introduced into the mass.

When the teeth have been moulded, they are placed in the furnace, and exposed to a temperate heat, which, without vitrifying them, renders them sufficiently hard to receive the enamel. To enamel teeth well is an operation that demands great care. It is necessary to commence by removing the dust carefully with a very soft brush, afterwards applying the enamel, which must have the consistence of a thick cream. When it is desired to give shaded tints to an artificial tooth, an enamel of any tint whatever, generally yellow, is applied upon the crown of the tooth and then coated with another layer of a light color, taking care at the same time to cover over lightly the other parts of the tooth.

To give to teeth of porcelain those fine shades which make them so much in demand by practitioners, different metallic oxides are used. To obtain, for instance, a clear rose tint, finely devided gold is added to the mass intended for the enamel or the base; to have the blood-colored purple, oxide of manganese is introduced; and to give to teeth that grayish tint with the blue shade peculiar to the natural tooth, an enamel containing platinum in its spongy state is added.

Of these different substances employed in coloring artificial teeth, spongy platinum, finely divided gold, and oxide of titanium are the most important. By mixing in different manners these three essential elements, almost all colors and shades required may be obtained.

Artificial teeth are manufactured in France, Belgium, Germany, England, and the United States, but it is in the two last-mentioned countries that the greatest excellence and perfection have been attained in this difficult and delicate operation.

The exhibition of the Champ de Mars gives additional evidence of the perfection of the artificial teeth produced in America.

Among the representatives of this branch of industry, Mr. Samuel S. White, successor of Jones and White, of Philadelphia, holds the first rank. The teeth exhibited by Mr. White are of irreproachable manufacture, and imitate nature in a remarkable manner. Their smooth surface, semi-opaque and enamelled, has not that appearance of vitrification so disagreeable in most artificial teeth.

Their form is excellent: they preserve the distinct character not only of the different teeth of the upper and lower jaw, but also of the right and left sides of the mouth. Their tint is a mixture of brown and yellow at the base and of bright and clear enamel on the sharp part of the tooth. They are at the same time light and solid, and a long practice has demonstrated to me their durability and superiority.

The porcelain gum block teeth, exhibited by this house, are of different sizes, and can be, consequently, fitted to every mouth. Those intended to be mounted upon hardened caoutchouc are provided with a headed pivot which prevents them from being pulled away from the base.

Among the American artificial teeth, those of Messrs. Johnson and Lund, destined to be set on caoutchouc, are distinguished by their natural appearance.

In a small box, of modest appearance, may be seen admirable artificial teeth, which constitute a new invention, and could not be too highly appreciated by practitioners. These are teeth exhibited by Mr. Samuel S. Stockton, of Philadelphia, teeth with mineral pivots and transversal holes, excellent products of this house, established for more than thirty years.

Messrs. Ash & Son, of London, have exhibited artificial teeth that rival in many respects American teeth, of which they imitate the enamel and form, without, however, entirely attaining the same perfection. Their plate teeth especially approximate to those of Mr. White, from Philadelphia, and their gold foil is very remarkable. The establishment of Messrs. Ash renders great services to European practitioners by the considerable assortment of artificial teeth which it places at their disposition.

Messrs. Ash & Son are entitled to the gratitude of the profession, not only on account of the varied selection which they offer, but also because of the zeal they manifest in constantly perfecting their productions.

Among the French exhibitors MM. Hôpital, Poirier, and Billard have exposed artificial teeth. Those of M. Hôpital, of Paris, imitate American teeth well enough, and possess over them the advantage of cheapness, but have neither their beauty nor solidity.

The teeth exhibited by Lemale, of London, are distinguished by their form and the beauty of their color, and Mr. Crane's artificial teeth made by hand are well worked.

DENTAL INSTRUMENTS AND GOLD FOIL.

Among the objects also exhibited by Mr. White is a case of instruments for dentists, which contains various articles, including some excellent forceps. All these instruments are as elaborate as ingenious; they are even injured by a too great finish, and a luxurious ornamentation which seems to me misplaced. Why, indeed, is it necessary to ornament with fine stones and incrustations, forceps, and other instruments required for constant use by the dentist?

The gold foil and spongy gold of Mr. White are also excellent productions.

The gold medal accorded to Mr. White is, in my opinion, only a just recompense for the excellent services rendered by his house, which employs 300 workmen, has more than 100 agents in Europe and the United States, and has received at home and abroad, at different exhibitions, more than 40 prizes or medals.

As I have just mentioned instruments of dental surgery and gold foil. I add a few observations upon these two articles. The manufacture of instruments of dental surgery offers so many and so great difficulties that few manufacturers have, up to the present time, succeeded in giving them all the desired perfection. In order to prepare the steel it is preferable to employ iron of Swedish production, and to give to the instruments a particular temper according to the use proposed to make of them. To temper steel it is necessary to first harden it as much as possible. and then to soften, or "draw," this hardness to the degree required by exposing it to the action of heat. The degree of heat differs according to the temper desired and the color which the steel is to possess: at 570° Fahrenheit, a steel well tempered and of a handsome blue tint is obtained: at 400° a straw-colored shade strongly tempered is secured.

Among the instruments used by the dentist the forceps form a specialty in which manufacturers rarely excel. Until lately, the best were produced in the United States; but Mr. Everard, of French origin but established at London, is to day manufacturing forceps which rival those of America. Instruments for filling teeth are most delicate articles, and their fabrication demands much caution and attention. They are of varied forms and temper. Some must be very hard in order to cut the enamel; some flexible and elastic to be adapted to special cases, while others must terminate in files or serrated points. Mr. Chevalier, of New York, Mr. Gemerie, of Philadelphia, and several others in America, excel in this kind of manufacture. The instruments of dental surgery which are made in England are well tempered, and the dentists' files fabricated by Mr. Stubbs, of Birmingham, especially enjoy a great reputation. It is proper to add that, since the last Universal Exposition, the French manufacturers have made remarkable progress in the production of certain instruments particularly destined for dental surgery. It may even

be said that the French files of the present day are nearly as good as the English.

The dentists' files of M. Romelin, of Paris, are very well made, and deserve to be recommended to the attention of practitioners.

As to the key covered with caoutchouc, which is seen in the show-case of M. Duchesne, I must say that it is a very old invention. The hook (*crampon*) which he exhibits is of a model similar to that of the jaw of the American forceps.

M. Gion, dentist of Paris, exhibits an obturator which appears to me to offer some advantages in operations upon the palate in cases to which it is applicable.

The apparatus for cauterizing, presented by M. Poirier, must offer serious inconveniences in practice. The instruments of dental surgery exhibited by M. Canali, of Pisa, are skilfully wrought.

Cadi Effendi, of Cairo, has also sent some of his products to the Universal Exhibition, but the surgical instruments which he offers for admiration are for the most part out of use to-day.

In dental surgery gold under different forms is used, whether intended for filling teeth or for entering into the composition of the many artificial pieces. For these pieces the operator should employ pure gold, or, at least, never any below 18 or 20 carats. For filling teeth, spongy and shredded gold are often used; yet gold leaf is more frequently resorted to. Of this latter there are several varieties to be noticed, known to the profession as cohesive, adhesive, and non-adhesive gold.

The manufacture of these different varieties is difficult; for it is necessary that the metal, although very soft and malleable under the hand of the operator, should nevertheless offer sufficient resistance and plasticity to adhere while cold, to settle solidly in the cavities, and adapt itself regularly to the sides of the teeth.

There are varieties of gold which are suitable more particularly for the preparation of gold leaf. Gold reputed pure is not, in an absolute degree, always so; for there is a certain license in commerce which, for that metal, varies from one to two thousandth parts; and in gold *commercially* pure, particles of foreign substances, such as iridium, are found, which are difficult to separate from the gold.

In order to obtain the metal perfectly pure it is necessary to precipitate the gold chemically and remelt it afterwards. The anvil upon which the gold leaf is beaten should present a surface perfectly clean, smooth, and brilliant as that of a mirror. The hammer used should likewise be clean and free from all rust. Otherwise, in beating the gold the oxide of iron would mix mechanically with the precious metal and deprive it of the properties which recommend it to the use of the practitioner. It is proper also to beat gold in a well-aired room where there is no dust which could introduce itself in the metal. Care should be taken in regard to the crucibles used for melting the metal. They should not contain any traces of metals, for the purest gold melted in defective

crucibles would lose something of its purity. Preserving gold leaf in tin cases must also be avoided, because they seem to have an injurious influence upon it, rendering it brittle, &c. It is only by following all these directions and observing these precautions that one may succeed in preparing a gold-foil which will answer the purposes required.

Mr. Abbey, of Philadelphia, sustains, by the gold leaf which he exhibits, the old reputation of his house, whose products, for the last twenty years, have surpassed all other manufactures of the same nature. This gold possesses all the essential qualities for filling teeth with success, whether it is wished to employ it without annealing, or to render it adhesive by submitting it to an elevated temperature. It has great uniformity of thickness, tenacity, coherence, softness, and a sufficient ductility.

M. Varentrapp, of Frankfort, also exhibits beaten gold which seems to me to be well prepared.

VULCANIZED CAOUTCHOUC.

After having spoken of artificial teeth, of gold leaf, and some other objects exhibited in the palace of the Champ de Mars, I think it my duty to mention a substance which has been rapidly brought into extensive use in dentistry, and which may be seen in nearly all the exhibiting cases at the Exposition: I allude to hardened or vulcanized caoutchouc. In a special brochure upon the discovery of this substance, and destined to establish my claims and rights to priority in the invention, I explained the good services rendered by it in a great number of buccal operations. I mentioned several cases where I had successfully substituted this substance for inferior and superior maxillary bones broken by fire-arms or other weapons.

I had thought, with all the American dentists, that artificial pieces offering the best conditions of use and durability were those made by means of metallic plates and mineral substances, such as porcelain.

On my arrival in Europe I remarked with surprise that in England and upon the continent most dental practitioners were using pieces of bone, of ivory, or of hippopotamus' teeth. First among the principal qualities of bone must rank that elasticity of fibre very anologous to that of the osseous tissue of the human frame, and also the fact that its specific gravity is less, rendering the contact of the pieces in bone softer to the gums than a composition of metal and enamel. These truths were evident beyond all question, yet at the same time I was compelled to notice faults and defects in its use which seemed to more than counterbalance its advantages. A set of teeth in bone, attacked by the salivary secretions, soon changes color; the substance decomposes, is affected injuriously, and must be frequently replaced.

A comparative study of the advantages and inconveniences of these two systems of artificial work determined me to institute, in the interest of humanity, a series of experiments tending to the discovery of some

material which, uniting the advantages of the two systems, should offer a permanent resistance to the action of the fluids of the mouth, while at the same time it should possess the lightness and elasticity of bone in its natural state. One of the substances to which my examination soon led me was caoutchouc. I then sought with perseverance the means of modifying its color and elasticity.

Not knowing then, as I do not know to-day, whether researches similar to my own had ever been made, I devoted to these studies the first part of the year 1848, profiting in that manner by the leisure which the events of that period[1] gave me.

Knowing previously that sulphur is but very little modified or decomposed in the mouth, the knowledge of this fact led me soon, by a very natural induction, to the idea of combining the caoutchouc with sulphur. After different experiments I thought of the application of dry heat, and succeeded in obtaining a substance hard, black, and possessing the elastic properties of horn. One of the first specimens was at that time carefully placed by the inventor in his secretary with the inscription: "I am seeking for ivory; I find ebony." Later, by employing moist heat, then steam or vapor, I obtained still more satisfactory results. In a word, the specimens of the composition which I finally succeeded in producing were in every particular similar to the vulcanized caoutchouc used to-day; the color alone was not so brilliant, and this defect I sought to correct from that time by the employment of different coloring substances.

From 1848 I continued my experiments in order to make advantageous use of caoutchouc in dental surgery. The discovery of caoutchouc, although comparatively recent, has nevertheless rendered surgical operations easier, which, before this discovery, offered remarkable difficulties. In my opinion, this substance is advantageously used when the molar teeth are to be very high, in a set for both jaws; then especially when the alveolar absorption has been very considerable in the under jaw; and, lastly, when, by reason of this absorption, it has become necessary to remodel and to restore the primitive conformation of the mouth and face. The use of caoutchouc is likewise advantageous when, on account of wounds or surgical operations, a fragment of bone has been carried off or removed and it is necessary to remedy this defect by artificial means.

There are still other cases where the use of hardened caoutchouc has given results which, I believe, could not have been obtained by employing any other substance; those cases particularly where, the bone having been fractured, it is necessary for the operator to replace it with a substance having the consistency of bone, in order to give a sufficient protection and support to the soft parts. Immediately after the Crimean war I had occasion to attend several French and Russian officers wounded at Sebastopol. The left part of the lower jaw of one of these wounded Frenchmen had been entirely fractured, and a large portion of the bone lost. I substituted a preparation in caoutchouc for the maxillary bone;

[1] The revolution of February, 1848.

and, owing to the facility with which this substance is adapted to every form, I succeeded entirely in restoring the damaged part, and in rendering to the face its original form.

A similar but more serious case was presented during the Italian war, after the battle of Solferino. While I was visiting the hospitals upon the field of operations my attention was called by the Minister of War to an officer whose maxillary bone of the upper jaw had been completely carried away by a ball. His condition, at first alarming, improved afterwards; but the nature of the wound prevented him from speaking. After the cicatrization of the wound I applied an apparatus in caoutchouc which, supplying the place of the maxillary bone, gave to the face its natural form, offered a protection to the soft parts, and restored to the wounded man the power of speaking. Many other analogous cases having come under my observation I have been enabled very often to employ hardened caoutchouc with success.

Still more recently I had occasion to perform an operation similar to the one I have just cited. During the last Polish insurrection a Russian general, well known, had his jaw badly shattered by a sabre cut. In this case again I succeeded in replacing the maxillary bone by an apparatus in caoutchouc, giving the face its original form, and at the same time restoring to the patient the power of speech.

An application of hardened caoutchouc not less fortunate has also been made in the United States. It is remembered that at the time of the assassination of President Lincoln, Mr. Seward, Secretary of State, was also the victim of an odious attack. He had the jaw broken by the arm of the assassin. After numerous endeavors without satisfactory results, the jaw was at last successfully restored by the application of an apparatus in caoutchouc.

One of the essential advantages of this substance—an advantage which cannot be too highly appreciated in a surgical point of view—is that one may give to it hardness or elasticity, according to the degree of heat to which it is exposed. It is proper also to remark that it is an inoxidizable and incorruptible substance, and consequently remains unaltered by the contact of the flesh, which it does not irritate or envenom like most of the metallic apparatus formerly employed. We cannot too highly praise the fortunate application made of it by a great number of surgeons, especially in America, where this substance is constantly employed for the manufacture of artificial pieces. In these last-mentioned cases hardened caoutchouc recommends itself by a new property in addition to the many others it possesses: that of being easily mixed with coloring matters so as to acquire the appearance of flesh. When colored in this manner an artificial dental piece may be made of it, or it may be substituted, with excellent results, for some soft part, damaged or defective.

The dark brown caoutchouc, hardened, is a compound of $66\frac{2}{3}$ of caoutchouc and $33\frac{1}{3}$ of sulphur; for the red color, 44 parts of caoutchouc, 2

of sulphur, and 23 of vermilion are employed; to obtain lighter or darker shades, zinc and earthy substances are added, according to circumstances.

Another quality which recommends the hardened caoutchouc to the surgeon's attention, in special and difficult cases, is the property it has of taking, by a proper moulding, the exact form of the bones or parts proposed to be replaced. All these properties of caoutchouc have made of it an excellent substance for preparing artificial palates. They were at first made with soft caoutchouc; but recently, and especially through the initiative of Dr. Bogue, of the United States, the lower part—that is to say, the principal part—is composed now of hardened caoutchouc and the upper of the ordinary substance.

These are the principal advantages gained by the use of artificial pieces of hardened caoutchouc. Constantly occupied for many years in perfecting the application of this substance to buccal surgery, I was curious to see what were the improvements made in this material since the day when first I had the idea of applying it to dental operations.

I will say that, after an attentive examination, I have not been able to discover any striking modifications in the composition of the substance, but it cannot be denied that some progress has been made in its coloring. All those who have been able to satisfy themselves of the blessings that the discovery of this substance has guaranteed to all classes of society must feel gratified in remarking that, except a few unprogressive or obstinate practitioners, all the dentists, to-day, use hardened caoutchouc either to replace bones or soft parts of the mouth, or to serve as the base for artificial teeth.

ARTIFICIAL PALATES AND SETS OF TEETH.

In many show-windows are found specimens of remarkable operations, but the more astonishing I find the models exhibited, the more perplexed am I to judge them. To substitute artificial pieces in place of maxillary bones, to rectify defects of the mouth and jaw, are delicate and difficult operations, but to judge them it is not enough to examine attentively the jaw exposed upon which the dentist has operated. It would be indispensable to know whether these difficult operations were timely and satisfactory, whether they accomplished the end desired, and, in a word, whether the patient has had cause to congratulate himself upon the result of the operations which he has undergone. Therefore I repeat that in the presence of these facts no opinion as to the merit or success of the operation can be formed.

MM. Jacowski and Debray have exhibited specimens of operations where the maxillary bone has been substituted by hardened caoutchouc, and M. Debray, of Paris, has placed in his exhibiting case a good piece of vulcanized caoutchouc, replacing the maxillary bone.

M. Preterre, of Paris, has exhibited numerous sets of teeth and artificial palates, as well as buccal pieces, very well assorted.

The artificial pieces exhibited by M. Dejardin present a great similarity to those of M. Preterre.

Mr. Nink also has produced some good pieces in hardened caoutchouc.

Mr. Weber, of Paris, exhibits specimens of black caoutchouc, which, being prepared without coloring matter, is lighter, more durable, and elastic. His preparation, which he furnishes to practitioners at moderate prices, is of great service.

M. Paul Boyer has exhibited artificial pieces like most of his confrères of Paris. He has also added to his collection machine tools of his invention. His air-tight furnace for warming, without explosion, the earthen vessels *(moufles)* which serve to receive the caoutchouc during the process of vulcanizing, is without doubt a very ingenious apparatus, but, I fear, will not render to the practitioner the services expected by the inventor.

The artificial pieces of Duchesne, in gold and caoutchouc, are superior to many other exposed in neighboring cases.

M. Rouy exhibits pieces carefully made; still there are too many embellishments in his artificial preparations. What is the good of carving or covering with ornamentel incrustations pieces which should be, on the contrary, very simple and plain, since they are to come in contact with the soft parts of the mouth?

But what is the object of the exhibition by M. Trousseau, of Rennes, editor in chief of a journal (the Abeille) devoted to dental surgery? I am astonished, I confess, that the chief editor of a journal pretending to be scientific should determine to exhibit.

As to the dentists of Germany, Austria, Belgium and Spain, the products which they exhibit are in no respect superior to those of their French confrères.

Mr. Eberman, of Prague, and Mr. Peffermann, of Vienna, exhibit some artificial pieces which, although heavy, are of a tolerably fine appearance. The dental board exhibited by Mr. Antoine Bousquet, of Valencia, in Spain, presents nothing striking; and the artificial work of Mr. Furtado, of Portugal, although pretty, is not superior to many similar productions.

Mr. Genotte, of Brussels, shows sets of teeth without springs, which appear to be of good construction.

Mr. Moore and Mr. Allen are among the small number of the dentists of America who decided to exhibit.

The teeth filled with gold by Mr. Moore do not constitute a new application.

Mr. Allen, of New York, shows pieces of continuous gums which, having to be put upon platinum, become heavy, but are incomparably the most beautiful pieces exhibited.

ANESTHETIC APPARATUS.

In painful operations the surgeon dentist willingly employs anesthetic agents.

Among these, ether and chloroform have been until lately the most often employed. Ether produces upon the nervous system an action similar to that of narcotics, while the insensibility determined or effected by chloroform is largely the result of a suspension of the respiratory function. The inhalation of ether and of chloroform often causes serious consequences, and sometimes produces the death of the patient to whom it is administered. Consequently surgeons, and more particularly those of the United States, have carefully sought some other substance capable of producing local or general anesthesia and free from the dangers incurred by the use of ether and chloroform.

I have observed in the United States collection in the Exposition of the Société de Secours aux Blessés an apparatus for the production and administration of nitrous oxide gas, exhibited by Dr. J. Q. Colton, of New York. It is but just to observe that through the efforts and researches of Dr. Colton, the attention of surgeons has recently been directed to the protoxide of azote or nitrous oxide gas. To Horace Wells, an American dentist, belongs the credit of having first demonstrated the anesthetic properties of this gas, several of whose peculiar qualities had been previously discovered by the celebrated English chemist Humphrey Davy.

But the discovery soon after of the same properties in ether caused the really original discovery of Wells to be quite forgotten until Dr. Colton had re-established by thousands of experiments the superiority of the protoxide of nitrogen gas over other anesthetics in dental surgery, particularly in operations which may be promptly effected. The gas has recently been even employed with success in Paris under my own direction, in the gravest surgical operations. The protoxide of nitrogen, composed of 36.4 of oxygen and 63.6 of azote, can be inhaled without any danger, when it is perfectly pure, and while breathing it, one feels more or less its agreeable sensations. Much and ingenious apparatus has been constructed in America for the preparation and inhalation of this valuable anesthetical substance.

M. Duchesne exposes apparatus for local anesthesia which appeared to me ingenious and well prepared. I must add, however, that M. Favre, of Paris, manufacturer of surgical instruments, claims priority in the invention; and, besides, this instrument appears to be a modification of Richardson's, of London.

There is still a large number of exhibitions made by dentists at the Champ de Mars, which I have failed to mention; it would be superfluous enumerate all, as the objects which they expose do not offer any notable differences. Here and there are samples of operations more or less authentic, and everywhere artificial teeth set with more or less elegance;

everywhere boxes and bottles containing marvellous powders and waters whose virtues it is impossible for me to state, but there is seldom any important discovery destined to promote the progress of dental science.

While declaring myself incompetent to render a judgment upon the powders and elixirs, which I have not been able to examine closely, I am far from denying the great importance of these articles in the practice of dentistry. The hygiene of the mouth is an essential thing for the preservation of the teeth, and, consequently, of the health in general.

The production of dentifrices and elixirs has lately developed rapidly, particularly at Paris, where it has attained considerable importance, by reason of the quality of alcohol prepared in France and the abundance of the article in the markets. In the manufacture of elixirs and tooth-powders one should have in view the employment of suitable medicinal substances concealed by materials fragrant and agreeable to the taste.

So long as manufacturers do not disregard this principle, one should, for the sake of hygiene, encourage rather than impede this trade.

Such is the dentist's exhibition at the Champ de Mars. I think that all those who study it carefully will agree with me in expressing the opinion announced at the commencement of this report, viz: that the dentist has no more reason or claim to appear among the exhibitors than the physician or surgeon.

Perhaps this report may also have shown how numerous and interesting are the trades connected with dental science. If it has accomplished this much I shall have fully attained the end which I had proposed.

PART III.

AMBULANCE AND SANITARY MATERIEL.

AMBULANCE SERVICE OF ARMIES—TRANSPORTATION OF THE WOUNDED—TRANSPORTATION OF MEDICINES AND SUPPLIES—HOSPITALS; TENTS; MODELS AND PLANS; FURNITURE—SURGICAL INSTRUMENTS AND APPARATUS—SANITARY SUPPLIES—MISCELLANEOUS—HOSPITAL TENTS—HISTORICAL.

AMBULANCE SERVICE OF ARMIES.

The exhibit made at the Exposition of the material connected with the ambulance service of armies is particularly complete and interesting. Governments and Sociétés de Secours, stimulated by a generous rivalry, or actuated by the purer purpose of contributing something which might serve to ameliorate the condition of the wounded and the suffering, have united their efforts in the service of a common and humane cause.

In the American department this material has not only been well represented, but surpasses, both in value and extent, any similar collection in the Exposition.

That this most gratifying result has been reached must be ascribed to some extent to the action of the Medical Bureau at Washington, a representative selection of the most important materiel in its possession having been carefully prepared by Surgeon General Barnes, and forwarded to Paris. It is to be regretted, however, that this valuable official contribution, disconnected at the commencement from everything of the same class, whether coming from the United States or elsewhere — and itself broken up and scattered over various portions of the palace and the park—has been so greatly overlooked and unappreciated.

As perhaps was to have been expected, almost nothing has been sent by inventors or private individuals. It was in anticipation of this—and impressed with the importance of having a creditable exhibition in a department which to me had long possessed a peculiar and absorbing interest, and to which I felt confident the United States, after a recent and extensive experience, could furnish most important contributions—that I proposed to form the collection which bears my name.

If the idea, as time passed, reached a fuller development and was ultimately crowned with more of success and honor than I had at first hoped for, it must be attributed less to any personal effort of my own than to the largeness of the field, the richness of the materials, and the revival again in the memories of men of those glorious charities which—through the long and weary years of a desolating war, unfaltering from

first to last—were ever present with the American soldier, in summer and in winter, on the rivers and by the sea, on the battlefield and in prison, in victory and in defeat.

The *Grand Prix d'Honneur* awarded to the collection, as representing the work of the United States Sanitary Commission, was the highest expression of estimation which it was possible for the Imperial Commission to give, but it can furnish a very imperfect idea of the value of the collection itself, or the great influence which it has had and will have both morally and materially upon the hospital service of European armies. The practicability of admitting upon the battlefield volunteer aid, of securing for the sick and wounded a more generous treatment, of realizing in a large measure those humane sentiments which so distinctively characterize our civilization, have received from it a new and forcible expression.

Placed with the ambulance materiel of nearly the whole world under the flag of the *Société de Secours aux Blessés Militaires*, it has been made during the past summer the subject of a most serious and exhausting study; and it is with no little feeling of national pride that I have seen American ambulances, medicine wagons, tents, plans for military hospitals; in fact, those things most essential to the sanitary service, subjected to the severest tests, and finally acknowledged and accepted as in principle the best of their kind.

The number of different articles exhibited in this section of Class 11 is so great that simple descriptions of each would fill a space many times larger than I have assigned for my whole report. It will therefore be only possible for me to name the articles exhibited, presenting such general descriptions and observations as may seem necessary in view of important principles or special merits, at the end of each category, which for the sake of convenience I have constructed, although perhaps somewhat arbitrarily.

TRANSPORTATION OF THE WOUNDED.

1 Ambulance, Wheeling; Surgeon General Barnes.
2 Ambulance, Rucker; Surgeon General Barnes.
3 Ambulance, Wheeling, improved.
Ambulance, Perot; Evans collection.
4 Ambulance, Rucker Brainard; Evans collection.
5 Ambulance, Howard; Evans collection.
6 Ambulance, Philadelphia Fire Company; Evans collection.
7 Ambulance, Evans; Evans collection.
1 Model of railway ambulance or hospital car, Harris; Evans collection.
1 Horse litter, Woodcock; Evans collection.
1 Wheeled hand-litter; Surgeon General Barnes.
2 Combined wheeled litter and fracture bed, Langer; Evans collection.
1 Hand litter, United States Army; Surgeon General Barnes.

2 Hand litters, United States Army; Evans collection.
3 Hand litters, Howard; Evans collection.
4 Hand litters, Stevens and Son; Evans collection.
5 Hand litters, Railway ambulance; Evans collection.
6 Hand litters, Evans; Evans collection.

That the American ambulances are superior to all others exhibited has been generally conceded by the most competent European critics.

Their principal merit is lightness, the heaviest weighing not over 1,300 lbs., while the average weight of European two-horse ambulances is about 2,000 lbs.

That lightness is not incompatible with sufficient strength is clearly demonstrated by the condition of the Wheeling ambulance exhibited by Surgeon General Barnes, it having borne the brunt of a long campaign with but little apparent injury.

Another excellence common to all the American ambulances is to be found in their covering of enamelled cloth or cotton duck, which, adding but little to the weight of the carriage, is sufficiently impermeable to rain, and renders a free and abundant supply of air always possible. Nearly all the European ambulances have wooden sides, ends and tops; in a word, are closed omnibuses.

The chief objection urged against all the American ambulances, except No. 7, is the difficulty of turning them, on account of the height of the forward wheels. This objection is one more apparent in Europe than in the United States, where an easy draught seems to be more readily obtained by increasing the height of the wheels, than by diminishing the badness of the roads. Still the objection is unquestionably a valid one.

Of the ambulances coming from the United States, the one made by Dr. Benjamin Howard, of New York, has been most highly commended. It has received an honorable mention from the Imperial Commission, and a silver medal (the highest prize awarded) from the special jury appointed by the *Société de Secours aux Blessés*.

Howard's ambulance is designed to carry two persons recumbent and two sitting, or eight sitting, besides the driver.

The mattresses to be used as stretchers slide easily into the carriage on rollers secured to a frame-work supported by inferior and lateral springs. The seats also rest on the same frame-work.

The ambulances constructed on the Rucker plan are capable of carrying four men recumbent. Whether the interior arrangement employed in these ambulances for the transportation of four recumbent be approved or not, it is unquestionable that the end sought is a most desirable one. Where but two men can be carried in an ambulance lying down, the waste of force in wagons, horses and men, must always be great. In most European armies it is actually enormous, since always, except on well-constructed roads, three or four horses are needed for each ambulance.

Locati, of Turin, has endeavored to remedy this difficulty, and exhibits an ambulance used in the Tyrol during the recent Austro-Italian war, which can carry five lying down, but the wagon, aside from being too complicated for general use, defeats its own end by being so heavy as to require the use of four or more horses.

Ambulance No. 7 (the Evans ambulance) was constructed with the purpose of uniting a possible capacity for four recumbent, with lightness, easiness of movement, facility of loading and unloading, and simplicity. It was however not finished until the last of August, so late as to be even *hors de concours* in the competition for the special prizes offered for the best ambulances by the Société de Secours aux Blessés. Nevertheless such were its considered merits, that the jury of the society saw fit to award to it a second prize of 500 francs, accompanied with an expression of regret that they were unable, in view of the fixed condition of the *concours*, to award to it the first prize.

This ambulance can carry ten persons seated, besides the driver and one or two attendants, or four lying down and two seated, besides the driver and one or two attendants. The seats can be used each as a mattress upon the floor of the wagon, the iron wheels with which they are furnished resting, when in position, upon springs beneath the floor. The object was to place these supplementary springs, first, out of the way; secondly, when once fixed, they would be secured against accidents. For the upper tier four rings of caoutchouc are attached, in front and rear, to the sides of the wagon, 2 feet 9 inches from the floor; two rings to an upright in the centre of the wagon immediately behind the seat of the driver, and two rings to a hook which may be dropped from the rear centre. By means of this arrangement, so very simple as scarcely to be observed unless special attention is directed to it, two ordinary French, English or American stretchers can be suspended whenever necessary, and two additional wounded transported in the most comfortable manner.

This ambulance weighing about 1,300 pounds is slightly heavier than the other American ambulances. The forward wheels turn readily under the body of the wagon. The top is covered with enamelled cloth, and folding seats are placed at the rear end outside for one or two attendants. It is furnished with a double tank for ice and water, and with a box for a few necessary supplies. Two stretchers are carried over head inside, and a supplementary one outside.

The model hospital car, made in accordance with specifications furnished by Dr. Elisha Harris, of New York, is one of the most beautiful and attractive objects in the American exhibition. Built on a scale of one fourth, it shows in detail exteriorly the construction of an ordinary American passenger car, and interiorly the special arrangement, couches, dispensary, wine closet, water closet, systems of ventilation, heating, &c., made for the comfortable transportation of the sick and wounded.

This model has been greatly admired by military surgeons, and although the plan cannot be readily adopted in Europe, owing to the peculiar con-

struction of most European railway carriages, it has occasioned much interesting discussion relating to the subject of railway transportation.

The Prussian government has very recently even directed a carriage to be constructed on the same plan.

The model was recompensed by a bronze medal from the Imperial Commission, and a silver medal from the *Société de Secours aux Blessés.*

Horse litters and wheeled hand litters were never much used in our army. A few of the former, either obtained in France or made on the French pattern, were issued early in the war, but were soon abandoned as not only inconvenient but unnecessary. The litter proposed by Woodcock of New York is much lighter than the French litter, but scarcely as comfortable.

Wheeled hand litters or barrows have long been employed on the continent, particularly in Germany, for the transport of the sick. Towards the close of our war, Neuss, of Berlin, sent a number of these litters to the United States, but they arrived too late to be of much service except as models. The use of wheeled hand-litters even in Europe, where populations are dense and the roads generally excellent, must always be exceedingly limited as compared with the use of the simple *civière* or stretcher, and yet it is curious as well as interesting to observe that the welfare and comfort of the wounded are at present regarded as of such paramount importance, that while but two or three new stretchers have been sent to the Exhibition of the *Société de Secours aux Blessés*, more than 20 different varieties of wheeled litters can be seen there.

Of the two American specimens I can only say that the first, essentially a copy of the Neuss litter and without the least merit of originality, is a good litter; while the second, entirely original with the inventor whose name it bears, is, as far as I have been able to comprehend it, entirely worthless.

The stretchers exhibited are all simple hand litters, and differ little from those in common use in the French and English armies. I consider the United States army pattern with the jointed yoke-piece equal if not superior to any. Howard's stretcher is a proposed improvement on one of the English models.

TRANSPORTATION OF MEDICINES AND SUPPLIES.

1. Medicine wagon; Surgeon General Barnes.
2. Medicine wagon, Autenreith; Evans collection.
3. Medicine wagon, Perot; Evans collection.

1. Coffee wagon, Dunton; Evans collection.

1. Medicine pannier (2), United States army; Surgeon General Barnes.
2. Medicine pannier, United States army; Evans collection.
3. Medicine pannier, Perot; Evans collection.
4. Medicine pannier, Dunton; Evans collection.

1. Hospital knapsack, Dunton; Evans collection.
2. Hospital knapsack, Perot; Evans collection.

1. Packsaddle, United States army, old pattern; Evans collection.
2. Packsaddle, United States army, new pattern, Evans collection.

1. Canteen, United States army, soldiers'; Evans collection.
2. Canteen, United States army, officers'; Evans collection.
3. Canteen, Confederate States army; Evans collection.

Medicine wagons Nos. 1 and 2 are designed rather for the transportation of medical stores in bulk than for dispensing; No. 3 rather as a dispensing wagon than for reserved supplies; all are light and well made, and greatly superior to the European *fourgons*. No. 3 is remarkable not only for the elegance of its construction, but for the very ingenious and effective systems employed to prevent the breaking of bottles; these being secured against fracture, either by the employment of springs upon which they rest, or by placing them in paper boxes, thickened at each extremity by bands which receive all concussions. This wagon received a silver medal from the *Société de Secours aux Blessés*.

To Mr. Dunton, of Philadelphia, belongs the credit of having invented a coffee-wagon, the only sample of a *cuisine ambulante* at the Exposition, excepting perhaps the *cuisine* of Dr. Roth, (English.) Pinner, of New York, has sent photographs, and Dr. Abel, of Vienna, has submitted the plans of a more complete kitchen. Still it is questionable to what extent these really interesting inventions may prove of practical utility except possibly in the service of volunteer associations.

Dunton's pannier, more expensive than several, is certainly one of the best exhibited. The bottles in this pannier are of block tin, internal and external surfaces of tin, between which is placed a thin lamina of wood. The bottles are light and strong, well secured at the mouth, and square in form. This pannier received a silver medal from the *Société de Secours aux Blessés*.

The knapsack of Perot is a slightly modified copy of the English "Field Companion." Mr. Dunton's is quite equal to any of the fifteen I have examined, and is entirely original both in form and mode of suspension.

Of the 16 canteens exhibited I prefer the French and United States regulation patterns, between which there is little difference; each holds about a quart, is of tin, and furnished with a woollen jacket; I can see, however, no advantage in the cotton suspension band of the United States canteen which can compensate for its slovenliness. For hospital or sanitary purposes, the "officers'" pattern is preferable; it is divided into two sections, each holding about a quart, is concave upon its inner surface, and, like the soldiers', is made of tin covered.

HOSPITALS; TENTS, MODELS, AND PLANS; FURNITURE.

1. Hospital tents, Wall, United States army (2); Evans collection.
2. Hospital tent, umbrella, Richardson; Evans collection.

1. Model of Lincoln hospital at Washington; Surgeon General Barnes

2. Model of a pavilion of Lincoln hospital at Washington; Surgeon General Barnes.
3. Section of a pavilion, showing a system of ventilation, &c.; Surgeon General Barnes.
4. Diagram of Lincoln hospital; Surgeon General Barnes.
5. Model of United States general hospital at West Philadelphia; Evans collection.
6. Diagram (ground plan) of United States general hospital at West Philadelphia; Evans collection.
7. Model of United States general hospital at Chestnut Hill, Philadelphia; Evans collection.
8. Lithographic view of United States general hospital at Chestnut Hill, Philadelphia; Evans collection.
9. Model of a pavilion of United States general hospital at Chestnut Hill, Philadelphia; Evans collection.
10. Model of a log barrack hospital, City Point, Virginia; Evans collection.
11. Lithograph United States hospital steamer Elm City; Evans collection.
12. Model illustrating a mode of heating a tent hospital; Evans collection.

1. Hospital bedstead, (iron;) Surgeon General Barnes.
2. Hospital mattresses; Surgeon General Barnes.
3. Hospital clothing, blankets, &c.; Surgeon General Barnes.
4. Hospital tables; Surgeon General Barnes.
5. Hospital bedstead, (iron;) Evans collection.
6. Invalid bedstead, (Crosby;) Evans collection.
7. Invalid mattresses; Evans collection.
8. Hospital clothing, blanket, &c.; Evans collection.
9. Water bed; Evans collection.
10. Bed table, (Stevens;) Evans collection.
11. Head rest, (Stevens;) Evans collection.
12. Camp chairs, stools, &c.; Evans collection.
13. Hospital mess chest, (Perot;) Evans collection.
14. One hospital bed, furnished; Evans collection.
15. Bed and pillow, (Pettiteau;) Evans collection.

But five different hospital tents are to be seen at the Exposition, or rather but four, as the tent used for hospital purposes in the French army is the common *tente conique.*

Of these four, the United States regulation (wall) tent is generally admitted to best realize the most important principles of construction: impermeability, convenience of form, ventilation, facility of pitching and striking, solidity, transportability, simplicity. Its really distinctive feature is the "fly." This has been unsuccessfully imitated in the Prussian tent, which I may also add is too large to be secure. The English

marquee tent is an excellent one, but being double, one tent within another, is costly and difficult to transport. By the employment of the "fly," a sufficient degree of impermeability is obtained without an excessive increase of weight and cost. The ventilation of the English tent is admirable, and I would suggest the introduction into our own regulation tent of the sliding ventilator employed in the inner tent of the English marquee.

Richardson's Umbrella tent, possessing many excellences, seems to me too complicated for field use.

Both American tents are made of cotton duck. The European tents are all of linen canvas. I prefer the former material; it is denser, less permeable to rain, and sufficiently durable.

The pavilion system of barrack hospitals so extensively and successfully used during our war, is well illustrated in the several models and plans exhibited. As to the superiority of this system over all others for the special purpose for which it was intended, there is at present but one opinion among military surgeons. Whether in Europe it can ever be as extensively employed as with us is doubtful. The duration of our war, the absence of public buildings, and the abundance of lumber, made it possible for us to give a most astonishing development to principles previously accepted, though less from experience than from theoretical considerations.

The method of ventilating commonly adopted in these hospitals (Leeds) has been regarded with peculiar favor; as have also many of the details connected more particularly with the administration.

Among the articles of furniture most worthy of notice is the iron bedstead generally used in our hospitals. Its lightness, the elasticity and strength of the slats, its compactness and cheapness, render it superior to any hospital bedstead I have examined: its only possible fault, a want of solidity, is a fault of execution rather than of principle.

SURGICAL INSTRUMENTS AND APPARATUS.

1. Field operating sets, (2,) Tiemann; Surgeon General Barnes.
2. Special operating sets, (4;) Surgeon General Barnes.
3. Trephining set; Surgeon General Barnes.
4. Pocket set; Surgeon General Barnes.
5. Field operating sets, (2,) Hernstein; Surgeon General Barnes.
6. Pocket operating sets; Surgeon General Barnes.
7. Field operating, Tiemann; Evans collection.
8. Minor operating, Tiemann; Evans collection.
9. Pocket operating, Tiemann; Evans collection.
10. Five trays of miscellaneous surgical instruments, Tiemann; Evans collection.
11. Instruments for the administration of ether, Lente; Evans collection.
12. Apparatus for the production and administration of nitrous oxide gas, Colton; Evans collection.

13. Set of splints, Day; Evans collection.
14. Set of splints, Winsted, Connecticut; Evans collection.
15. Fracture apparatus, Buck; Evans collection.
16. Instruments and preparation illustrating a mode of operating in compound fractures, Howard; Evans collection.
17. Artificial limbs and apparatus for exsections and resection, Hudson; Evans collection.
18. Field operating table, Perot; Evans collection.
19. Field operating table, Autenreith; Evans collection.

While the official field operating sets have contained nearly all the instruments generally required by the regimental or staff surgeon, I believe a desirable end would be accomplished by adding to each set a small capital operating set or *trousse*, which might be carried in the medical knapsack or elsewhere. Very beautiful samples of these trousses are to be found in some of the French or Italian knapsacks. The one proposed by Professor Esmark, of Kiel, is the most compact, and can be carried easily in the pocket. Mr. Tiemann has sent a small case, (Tray No. 5,) which might be used in this way, but the system of employing but one handle for several blades, which the case is chiefly intended to illustrate, is open to many and serious objections.

The surgical instruments exhibited by the establishments of Messrs. Tiemann and Hernstein are equal in elegance and finish to any exhibited by the most celebrated European makers. "In execution nothing more could be desired."[1] The display is an exceedingly fine one, and is alike creditable to the manufacturers and the country. Mr. Tiemann is the recipient of a silver medal from the Imperial Commission.

The light wooden splints of Day, Winsted & Co. are novelties in Europe, and have been examined with much interest, as have also the instruments for the better administration of ether, and for the production and administration of nitrous oxide gas. The dangers resulting from the indiscriminate use of chloroform are daily more generally recognized by European surgeons, and earnest efforts are now being made to discover either safer methods of administration, or new and less dangerous anæsthetic agents.

The number of artificial limbs exhibited is not great, but the selections were well made. The American limbs are generally more highly finished than those made in Europe; the price also, it must be stated, is considerably greater. Dr. Hudson has received from the Imperial Commission a bronze medal for the limbs sent by him, which have been particularly admired, and are in execution unquestionably the most remarkable in the Exposition.

SANITARY SUPPLIES—EVANS COLLECTION.

Clothing.—Blankets, bed-quilts, bed-sacks, cushions, drawers, handkerchiefs, mittens, sheets, shirts, dressing gowns, socks, slippers, towels, &c.

[1] Report of Professor Gurlt.

Food.—Apple butter, barley, beef, (dried,) beef stock, (Martinez,) broma, (Baker's,) cabbage, (pickled,) canned fruits, corned meats, corned vegetables, catsup, cheese, chocolate, (Baker's,) cocoa, (Borden's,) coffee extract, (Borden's,) condensed milk, (Borden's,) dried sweet corn, pop-corn, crackers and biscuits, dried fruits, eggs desiccated, (Lamont's,) flavoring extracts, (Woodruff's,) farina, (Hecker's,) flaxseed, groats, hickory-nuts, hominy, Iceland moss, jellies, julienne soup, lemonade condensed, lemon extract, lemons, limejuice, macaroni, maizena, (Duryea's,) molasses, mustard, nutmegs, oatmeal, oranges, oysters pickled, pickles, potatoes, prunes, rice, sago, sardines, spices assorted, sugar, tapioca, tea, tobacco, (Gail and Ax,) vegetables desiccated, vermicelli, yeast powder, ale and porter, (McPherson and Donald Smith,) blackberry brandy, brandy, (F. S. Cozzens,) cider-champagne, (J. Kiernan,) ginger extract, (Frederick Brown,) Jamaica rum, (F. S. Cozzens,) raspberry vinegar, sirup, whiskey, (F. S. Cozzens,) domestic wines, (F. S. Cozzens,) foreign wines, (F. S. Cozzens,) &c.

Miscellaneous.—Adhesive plaster, alcohol, bandages, baskets, brooms, brushes, buckets, buttons, candlesticks, combs, chairs, coffee-pots, cologne, comforts, cotton batting, crutches, envelopes for letters, eye-shades, pens, feeding cups, feeding tubes, games, lanterns, letter paper, lint, oakum, oil-silk, pens, paper bags, pins, pipes, sponges, spit cups, yarn, &c.

The collection of sanitary supplies is one of peculiar interest as a material indication of the direction of popular philanthropy during our war. The liberal provision of the government had secured an unusually abundant supply of medicines, surgical appliances, and all the more important stores pertaining to the hospital department.

The object of volunteer aid was to furnish those things which are most likely to be needed in pressing exigencies, certain articles of hospital clothing and food, or those supplies which, perhaps not absolutely indispensable, might contribute greatly to the comfort of the sick and the welfare of the army.

Samples of nearly everything contributed by the people to the soldier are here to be seen. The home-made blankets and counterpanes, hospital wrappers, caps and slippers, the curious little comfort-bags filled with note paper, stamped envelopes, hymn books, combs, brushes, needles, thread, tape, buttons, &c., bearing with them, perhaps, some woman's word of hope and encouragement—all, the simple, silent but eloquent witnesses of a noble work of loyalty, love, and charity most worthily accomplished. Probably no articles in this class have been examined with more curious interest or elicited more admiration than these. Not only have they shown precisely what the American people did do for their army, but they have shown what other people can do. As is the case with most good works, the agency of the Sanitary Commission has been felt beyond the circle of those necessities which first created it, and its influence in widening the domain of human interest and

sympathy has been not less apparent and important than the material service which it has rendered.

Among the articles of diet the preparations of canned food occupy a prominent rank, whether considered in view of their intrinsic value or the immense demand for them in the general *cuisine* of the army. The meats, vegetables, and fruits put up in this way were usually of good quality and cheap, as were also the jellies and preserves. Some of these articles, such as green corn, cranberries, okra, &c., are almost entirely unknown in Europe, while in a large number of cases the preparation only is new as an article of commerce. Still, most of these things can be found in foreign, particularly in English markets, as well prepared, sometimes better than in our own. Borden's condensed milk, and extract of coffee with milk, particularly the former, are so well known to the American public as to little need the sanction of European favor. The English and continental preparations of milk have generally been inferior in quality, or at least have never become popular. Less than a year since a company in Switzerland commenced the manufacture of milk on Borden's principle. Our own European navy is now chiefly supplied from this establishment, and the rapidly increasing demand for the milk has completely assured the success of the enterprise. The extract of beef, recently prepared by the same manufacturer, Borden, is of remarkable excellence. It has generally been regarded here by those who have carefully examined it as superior to the somewhat celebrated *extractum carnis* of Liebig, and as the best concentrated extract of meat now known. Its introduction into the sanitary service of European armies has been strongly urged.[1]

A silver medal was awarded to Mr. Borden for this preparation by the *Société de Secours aux Blessés.*

Duryea's maizena, Lamont's desiccated eggs, and several other strictly American preparations have also been highly commended.

MISCELLANEOUS.

1. Umbrella tent, officer's; Richardson; Evans collection.
2. Umbrella tent, officer's; Walton; Evans collection.
3. Life-boat; Evans collection.
4. Samples of clothing issued by the United States government to infantry soldiers; Evans collection.
5. Cavalry stirrups; Evans collection.
6. Sanitary Commission tool case; Evans collection.
7. Sanitary Commission mess kit; Evans collection.
8. Officer's mess chest; Perot; Evans collection.
9. Field mess chest; Perot; Evans collection.
10. Mess pannier; Dunton; Evans collection.
11. Platform scales; Fairbanks; Evans collection.
12. Balances; Evans collection.

[1] Report of Baron Munday.

13. Anthropometer; Evans collection.
14. Spirometer; Evans collection.
15. American combined knife and fork; Evans collection.
16. Spike candlesticks; Evans collection.

A much more complete exhibit of the clothing issued by the government during the war has been made in another class. The mess utensils are of no special interest. Nos. 11, 12, 13, 14 are instruments used by inspectors of the Sanitary Commission, while conducting observations to determine the weight, strength, physical development, &c., of soldiers recruited in different sections of the country, or representing different elements of population or social condition.

HOSPITAL TENTS.

Hospital tents should be impermeable to rain, convenient in form, capable of being well ventilated, of being easily pitched and struck; simple in construction, light, compact when ready for transportation, and, withal, sufficiently secure when pitched.

In order that the first requisite, impermeability, may be properly secured, every hospital tent should have a double roof or "fly." This principle has been observed in the construction of the English, Prussian, and American regulation tents, which are also what are termed "wall tents"—that is, are made with sloping roofs and perpendicular sides. This form is preferable to the "conical" or "wedge" not only in view of its being better adapted to receive the protection of an upper roof or "fly," but from the greater ease with which the interior space is utilized. The objections against these tents are, that they are more likely to be blown down by heavy winds than either the conical or wedge tents; and that they compel the employment of an additional number of poles and guys. Experience shows, however, that, unless too large, they are sufficiently secure; and the burden upon transportation can hardly be regarded as considerable, in view of the limited nature of the ambulance service and the special and important objects to be gained.

In the French army no tent is used especially by the ambulance service—the ordinary "tente conique," for sixteen foot soldiers, being the one generally employed for this purpose. The diameter of this tent is 5.70 metres, its height 3.25 metres; weight 72.14 kilograms, and cost 237 francs. It is made of linen canvas, is supported by a single centre pole, and is guyed out by short cords. Its extreme diameter from picket to picket is 6.50 metres. The bottom of the tent is furnished with a curtain 0.36 metre in breadth, which can be raised for purposes of ventilation, while a permanent opening in the top permits the escape of foul air.

This tent possesses almost all the essential requisites of a service tent, although the material is too loose in texture, and not sufficiently impermeable; as an hospital tent, however, we cannot approve it; it is

inconvenient in form not only for the patient but also for the surgeon and the attendants.

The Prussian tent exhibited, is an oblong wall tent 13.33 metres long, 6.65 metres large, 4.33 metres high, with side walls 1.50 metre high. It is supported upon a tubular iron frame, and made steady with guys. It has a double roof, and a curtain at each extremity which drops from the roof to the ground, cutting off a space between itself and the end wall 1.30 inch in width. In the roof are two circular openings for ventilation. The material of which it is made is linen canvas of fair quality, cost 1,300 francs. The Prussian tent is too large for easy handling and transportation; it offers, also, too extensive a surface to the wind, as it cannot be made sufficiently secure without employing a frame-work undesirably complicated and heavy. Although a double roof or "fly" is used in this tent, its principal advantages have been lost by retaining it in close apposition with the roof of the tent itself.

The English hospital marquee is a double tent; the inner tent is 28 feet long, 15 feet wide, and 12 feet high, with a cubic space of 2,596 feet. The lower part is elliptical, with straight walls 5 feet in height; the upper part is in the form of a triangular prism and two half cones. The tent is suspended by bands from a ridge-pole 14 feet long, supported by three upright poles each 14 feet in length, and each in two sections, and is guyed out by cords. The outer tent, entirely covering the inner tent, rests upon the ridge-pole and is retained in its place by guys. The average distance between the two tents is about two feet. The walls of both tents are in section, and hook upon the roofs entirely around the sides and ends. Upon each side of the roof of the inner tent is a sliding ventilator, which corresponds with a hooded opening in the outer roof.

The material of which the tent is made is linen canvas of good quality. Cost and weight unknown. This tent is, undoubtedly, excellently adapted for hospital purposes. It is convenient in form, impermeable, capable of being easily and thoroughly ventilated, and is secure when pitched. The objections to it are its cost and weight; two entire tents serving but for one. Inasmuch as the outer, larger and more expensive tent serves but an accessory and secondary purpose, we must regard the construction of this tent, notwithstanding its evident excellencies, as radically faulty.

The "umbrella" tent made by Mr. Richardson, of Philadelphia, and exhibited for the United States Sanitary Commission, is a large circular tent 6 metres high, and 7.88 metres in diameter at the base; supported by a central pole made in two sections, and by arm pieces radiating from the centre, which, by a hoisting apparatus, spread the tent out something after the manner of an umbrella. The roof is stayed by short cords, from the insertions of which a curtain, 0.61 metre in breadth, drops perpendicularly to the ground. The material employed in the construction is cotton duck; cost 700 francs. This tent possesses certain merits. It is well ventilated at the sides and top; can be readily pitched

and struck; its form when packed is well adapted to transportation, and the interior is spacious and convenient. No special provisions have been taken, however, to make it impermeable to rain, and the complications of its construction are too considerable. Small props are liable to be broken, joints are likely to get out of order, and in the field it is not always easy to supply the one or repair the other.

The hospital tent exhibited for the United States Sanitary Commission, and generally employed by the United States government during the late civil war, is 14 feet in length, 15 in width, and 11 feet (centre) in height, with side walls 4½ feet high. It is intended to accommodate eight patients. The tent is supported by two poles and a ridge-pole, each made in two sections. One end is furnished with a lapel so as to admit of two or more tents being joined and thrown into one, with a continuous covering or roof.

Each tent is also furnished with a "fly" or extra covering, which, resting upon the ridge pole, and elevated several inches above the roof proper, entirely covers it.

The material employed in the construction of this tent is closely-woven cotton duck, and the cost of each tent about 300 francs.

The advantages possessed by this tent are its simplicity, cheapness, square form and perpendicular walls; the almost entire impermeability of the material employed in its construction; and, finally, the "fly," which, while it is an additional security against rain and humidity, is also an effective defence against solar heat, the space between the two roofs being open to a free ventilation. Again, the "fly" being movable, it can, during dry and pleasant weather, readily be advanced in front of the tent, thus increasing to a considerable extent the amount of shelter furnished. In this tent no special arrangement has been made for roof ventilation. This is perhaps a fault; one, however, which can be easily remedied should ventilation from the ends be at any time apparently insufficient or defective.

This American (regulation) tent certainly possesses in construction great merits, while the material of which it is made (cotton duck) is less permeable and less expensive than linen. Whether it may prove sufficiently durable in all climates to be economically employed, is a question which can only be determined by experience.

HISTORICAL.

1. Histoire de la Commission Sanitaire des Etats-Unis; Evans; Evans collection.

2. Discourse of Rev. Dr. Bellows, president of the Sanitary Commission; Evans collection.

3. Reply to the question why the Sanitary Commission needs so much money; Knapp; Evans collection.

4. Memorial of the Great Central Fair; C. J. Stillé; Evans collection.

5. Military Statistics; Elliot; Evans collection.
6. Tribute Book; Goodrich; Evans collection.
7. Medical and Surgical Essays; Hammond; Evans collection.
8. Three Weeks at Gettysburg; Evans collection.
9. History of the United States Sanitary Commission; C. J. Stillé; Evans collection.
10. A Brief History of the United States Sanitary Commission; Evans collection.
11. Essais sur la Chirurgie et la Médicine Militaire, Translation; Evans; Evans collection.
12. Les Institutions Sanitaires pendant le conflit Austro-Prussien-Italien; Evans; Evans collection.
13. Charts, Diagrams, &c., of the United States Sanitary Commission; Evans collection.
14. Photographs of Places Made Memorable by the War; Evans collection.
15. Guerre d'Amérique; Evans collection.
16. Groups (5) in terre cuite; Rogers; Evans collection.
17. Lithographs of the Bazaars of the Sanitary Commission in Philadelphia; Evans collection.
18. Photographs of Pinner's ambulance; Kitchen; Evans collection.
19. Autographs of 19,108 persons who have undergone surgical operations under the influence of nitrous oxide gas; Colton; Evans collection.
20. Picture frame made by a wounded soldier; Evans collection.
21. Tribute to the Ladies of New York; Dusseldorf artists; Evans collection.
22. The Wounded Soldier; Carl Hubner; Evans collection.
23. Frame enclosing photographs, medals, &c., of the United States Sanitary Commission; Evans collection.
24. De la Découverte du Caoutchouc Vulcanisé et de la Priorité de son Application à la Chirurgie Civile et Militaire; Evans; Evans collection.
25. Treatise on Military Surgery; Hamilton; Evans collection.
26. Army Regulations, (United States;) Evans collection.
27. Various publications of or pertaining to the United States Sanitary Commission; Evans collection.
28. Circular No. 6, Surgeon General's office; Evans collection.
29. Micro-photographs; John Dean; Evans collection.
30. Sanitary Commission mail-bag of the Army of the Potomac; Evans collection.
31. Flags of the United States Sanitary Commission; Evans collection.
32. Rubber rings used in one of the United States Sanitary Commission hospital cars; Evans collection.
33. Photographs and micro-photographs of objects in the Army Medical Museum at Washington; Surgeon General Barnes.

34. Various reports and publications of or pertaining to the United States Christian Commission; Evans collection.

35. Loan library United States Christian Commission; Evans collection.

36. Flags of the United States Christian Commission: Evans collection.

37. Knapsack of a field delegate of the United States Christian Commission; Evans collection.

The history and literature of our hospital service is well represented by books, diagrams, photographs, &c. If perhaps a less striking, it presents a completer record of the means employed for the relief of the sick and wounded than is elsewhere shown. "The History of the Sanitary Commission," "The Tribute Book," and "Woman's Work," are the imperishable records of earnest effort, of generous sacrifice, of heroic fortitude and devotion. From them we may learn the loyalty of both the army and the people to the government, the close relation of the army to the people, and the keen appreciation by the people of the special dangers, sufferings, and necessities which were to be encountered and borne by the newly-made soldier. From them we may discover the sources of that inspiration which, to diminish these evils, created in a few weeks a vast machinery covering the country with a net-work of branches, having their subordinate centres of charity in every village and hamlet, and maintained for more than four years with unabated efficiency the most extensive, as well as the most successful, philanthropic work ever before undertaken.

From Circular No. 6 and the remarkable photographs sent from the office of the Surgeon General, we learn something of the organization of the medical staff, of the wide field of its operations, and of the appreciation by the medical bureau of the immense collection of statistical, surgical, and pathological material with which its offices were filled at the close of the war.

It certainly is to be regretted that a more complete exhibit was not made of the general orders and circulars from time to time issued relating to the medical staff, as well as of the various returns or forms in use. With a clearer understanding of the organization and services of the medical staff, of the reasons for the modifications and changes which it was ultimately found necessary or expedient to adopt in it, of the absolute data sought, in regimental and hospital, medical and surgical statistics, the world would have been better satisfied to wait for conclusions and results whose value is now in danger of being impaired by a somewhat slow process of evolution. Enough, however, has been shown to indicate the remarkable fidelity with which these medical records have been made and preserved, and their really incalculable value in the solution of some of the most important questions of the present time, and it is earnestly to be hoped that our government may accord to the medical bureau every encouragement and facility necessary to their speedy preparation for publication; a publication as essential to the reputation of our country as imperatively demanded in the general interest of sanitary science

The reports and publications of the Christian Commission indicate the character and extent of the moral and religious influences brought to bear upon the soldier, and the earnest efforts made to check the vices and counteract the demoralization peculiar to camp life. We have here a sample of those "loan libraries" furnished by hundreds to hospitals, regiments, and ships, not filled wholly with sermons and religious tracts, but composed principally of books of travel, history, and science. No better illustration could have been furnished than this of the average intellectual tastes of our soldiers and sailors.

The little parchment "identifier," "to be worn in battle under the shirt," with a blank on one side for the name of the soldier, and on the other for the address of father, mother, or sister, is a touching instance of tender forethought.

How many sad yet pleasant memories of the camp are called up by those modest placards headed "Soldier's writing table; sit down and write a few words home; if you have no postage stamps, leave your letter in the box, we will stamp and mail it." Had we not seen these things with our own eyes, we should have been half inclined to doubt the possibility of all this goodness.

If war is a scourge and a desolation, it is not always an unmixed evil. If the baser passions of our nature are unloosed, our forgotten virtues too are aroused from their dead slumbers, and, all the purer and brighter and more conspicuous amidst the general darkness and gloom, repeat to us the story of our fall, and again assure us that we are still the children of a Divine Father who will finally receive us into that kingdom where all is charity and peace.

In concluding this report I can only regret my inability to render it more complete, a better representation of our exhibit at the Exposition, and a fuller summary of the results of studies which have extended over a much wider field. Still, however desirable it might have been to have considered this special section of Class 11 from an international point of view, and to have instituted a comparative criticism of the articles exhibited by different governments, such was not the purpose of the present report. The undertaking was too vast, and on the whole perhaps of doubtful utility.

Many of the methods employed in the hospital service, as well as many of the most important principles involved in the construction of hospital material, will always be determined by social, climatic, topographical, or other local considerations. While most of the hospital material exhibited by the different States of Europe has been well devised with reference to the special end to be accomplished, as we have already stated, much of our own material is equal and some certainly superior to that shown by any other nation. Still, while we have every reason to feel gratified with the results of the Exhibition, as they may regard this portion of our subject, it may be well to remember that there is little which may not be improved, often even by adopting principles

employed in models in themselves inferior. We may sometimes teach: it is always possible to learn; and if others have profited by the study of this rare assemblage from all quarters of the globe of the most approved material of the ambulance service, the benefit should have been to us no less. If our merits have at times been recognized, we have had occasion more than once to confess our faults, and admit with all the world the many practical difficulties which must always interfere with the full accomplishment of our wishes in behalf of the wounded on the field of battle.

PART IV.

MILITARY SANITARY INSTITUTIONS IN EUROPE.

The Prussian Society of Relief for the Wounded—The Prussian Sanitary Institution during the combat of Langensalza—The Prussian Society during the battle of Sadowa—Knights of the orders of St. John and Malta—Relief Societies in Saxony and Southern Germany—Austrian Relief Societies—Italian Society of Relief to the Wounded—Conclusion—Treaty for the Amelioration of the Condition of Wounded Soldiers.

PRUSSIAN RELIEF SOCIETIES.

When in the spring of 1866 war broke out in Germany, my attention was directed naturally, and in a manner quite special, to the hospital and sanitary organizations of that country. It appeared to me that by studying these organizations in belligerent countries, and comparing them with similar institutions which I had investigated in America and elsewhere, some useful information might be obtained. By repairing to the theatre of events in order to better examine the questions which had occurred to me, I considered that I was fulfilling a duty, the more so because before the war their majesties the King and Queen of Prussia had repeatedly expressed to me their unqualified sympathy with the work accomplished by the United States Sanitary Commission, and had deigned to encourage me in the efforts I was making to propagate the idea of a sanitary enterprise similar to that which in America had rendered such great services to humanity. The following is the manner in which the King expresses himself in an autograph letter:

"Baden, *October* 13, 1865.

"Accept the assurance of the great interest derived from the work which you have transmitted me through the agency of the Queen. She has conveyed to you in my name the token of esteem which I destined for you on account of your important medical researches; but I wish by these lines to state the purpose which honors them; the alleviation of suffering in general, and the amelioration of the sanitary conditions of armies. WILLIAM.

"To Thomas W. Evans, M. D."

Would the principles adopted by the Genevese convention answer general expectation, now that they were put in practice upon a vast scale? How were the relief committees going to operate? Will they adopt some of the measures tried and found good during the great war in the United States. What improvements or modifications will they introduce in the American system to adapt it to the customs of Europe

and to the exigencies of a war undertaken under different circumstances? Such were the questions which presented themselves to my consideration: such was the problem I proposed to investigate.

One of the first things that struck me when I entered upon the territory where important events were taking place, was the presence of a large number of volunteer hospital attendants at most of the railway stations. They wore upon the arm the badge of the international society, the red cross upon a white ground. They were there awaiting each convoy, and ready to render assistance to whatever wounded soldiers, friends or enemies, the train might bring. I was reminded of the volunteer hospital attendants of the American Sanitary Commission, who also prepared at the stations, "refreshment rooms," and "homes," for the sick and wounded returned from the fields of battle. But while recognising with an unfeigned satisfaction the similarity existing between the two organizations, I remarked immediately a difference which seemed to me important. In America female attendants were seen everywhere, even at the railway stations, rivalling in devotion the men, while here there were none. This deficiency struck me forcibly.

But before communicating the reflections which the operation of the new hospital and sanitary institutions in Germany may suggest, a brief account of the origin of these institutions in that country, and particularly in Prussia, may be advisable.

It is known that this power was one of the first to sign the Geneva convention; it was also destined to inaugurate the reform and make the first practical experince of it.

Although the King of Prussia signed the treaty on the 24th of August, 1864, as early as the month of February of the same year a relief society was formed at Berlin—the Central Prussian Society—which entered into active service the following month, the campaign of Schleswig-Holstein having commenced. This campaign, undertaken during the winter, had brought forth sufferings that forcibly invoked public attention. The Central Prussian Society, whose headquarters were at Berlin, made an appeal to the people, and in a few days had at its disposition 4,000 thalers. This certainly was not a very considerable sum; nevertheless the committee were prepared to make such a judicious use of it that, from the commencement, the army felt the beneficent action of the institution, and shorly afterwards contributions in kind were received in sufficient abundance to relieve effectively the most urgent necessities. This committee found itself at the head of an institution without precedent in the military annals of Europe; consequently it became necessary for it to advance prudently and, if I may so speak, gropingly. It commenced by sending to the theatre of war one of its most distinguished members, Dr. Gurlt, professor in the faculty of Berlin. This delegate had more particularly for his mission the studying of the ways and means of transporting the wounded from the field of battle.

It was not long, however, before it was discovered that it was indispen-

sable for the society to be represented in a permanent manner upon the field of operations. For this purpose Colonel de Malochowski and Major de Witje were sent as delegates of the committee, and, through the devoted activity of these intelligent men, a depot was immediately organized in the city of Flensburg, the very centre of military operations, so that lint, instruments of surgery, bedding, medicaments and alimentary supplies could be delivered to the surgeons of the army instantaneously and as they required them.

Although the number of wounded did not exceed the foresight of professional men, yet the military hospitals contained more sick and wounded than the space which they could dispose of admitted, and considerable mortality followed. In presence of this fact the relief society appealed to all the rural proprietors of Schleswig-Holstein to ascertain if they could be disposed to receive at their homes wounded soldiers. To this appeal the population responded with such eagerness that it was impossible to accept all the offers made. From that moment overcrowding ceased in the hospitals, wounds healed more regularly, and the proportionate rate of mortality decreased considerably. In addition, the central committee, with resources still restricted, found the means of delivering sums of from 20 to 100 francs to most of the invalids who left the hospitals.

Such were the acts which the Prussian Sanitary Commission was able to accomplish during the Schleswig-Holstein war. We do not see in this, it is true, brilliant and unexpected results like those which signalized the beginning of the United States Sanitary Commission; still it would be unjust to disparage the spirit which the people exhibited, from the commencement, in a work for which they were not prepared. The central committee of Berlin accomplished, in a sphere restricted in appearance, a very great and very considerable work considering the resources which it possessed, and the novelty of the enterprise which it was inaugurating before attentive Europe. I purposely say that Europe was attentive, for we must not forget that at the time when the central committee entered upon its work, the statutes of the Geneva conference were still untried, and the realization of the principles which they enunciated appeared scarcely probable, if not impossible, to some of the persons who had assisted at the debates of the conference. Consequently great interest was attached to the enterprise attempted by the Prussian Relief Society, and the happy results obtained, have strongly contributed to the conclusion of the international treaty which was signed in the city of Geneva.

After the Schleswig campaign the central society, faithful to an article of that treaty, remained in active service with a view of preparing, during peace, the means of succoring the wounded when war should again break out.

The services rendered by the Prussian Sanitary Society were appreciated by the war department to such an extent that after the Schleswig-Holstein campaign, and in time of peace, the government not only resolved to protect this institution, but to give it a greater devel-

opment. As early as the month of April, 1865, the central committee was advised that the King and Queen took the work under their immediate protection.

In April, 1866, when the political horizon was darkening with storm-clouds, and minds accustomed to sounding the future foresaw the possibility of a conflict with Austria, the Prussian Society received from the King the right of corporation. This was a great privilege, for from the moment it was recognized as a corporation by the state, its individuality was established, and it possessed thereafter the power of selling and buying, of building and endowing, of pleading and defending.

At the same time the government made known that it would be desirable for the central committee, whose headquarters were at Berlin, to become for the future the central organ of public charity, in order to avoid the conflict and confusion which had marked the first efforts of the society at the commencement of the Schleswig campaign. After these different communications with the government, and especially after the proclamation in which King William called all Prussia under arms, the central committee modified its statutes and addressed to the nation an energetic appeal.

On all sides local relief societies were organized, which attached themselves to the mother society; and gifts in money and supplies were sent forward to Berlin from all parts of the monarchy.

When I visited the Prussian capital, (the war was then at its height,) the central depot of this institution was established in one of the most opulent quarters of the city; but the premises appeared to me a great deal too limited for the use to which they were destined. Offerings had arrived there in abundance; enormous boxes obstructed the passages: objects of every nature, mattresses, oil-cloths, instruments, bandages, &c., were lying about without order on the stairways. In the same rooms persons were busy in receiving the supplies which arrived, and in shipping others to the theatre of war; the workmen who packed labored side by side with those who were unpacking. They were nailing and shouting; the noise of the hammers mingled with the voices of superior employers, who were replying to the comers and goers; orders and demands were addressed on all sides, and at times violent discussions arose. While contemplating the noisy and somewhat confused scene which presented itself to me at the central depot of Berlin, I could not dispel a sentiment of sadness in thinking how easy it was in the midst of such a tumult for an order to be misunderstood or an urgent expedition retarded. For in like occurrences, does not the least delay or the least error compromise hundreds, if not thousands of existences? I may add, however, that my apprehensions were not well founded, and that after having seen closely the difficulties in detail against which the central committee had to contend, I have been only the better able to appreciate the great things accomplished, and to recognize with what promptitude, with what order and precision it distributed the treasures of

which it was the depository. It is proper also to remark that, to enlighten it upon the needs of the army and to aid it in producing the greatest amount of possible good, the central committee had at its side an essential organ; indeed, as soon as it was realized that war was inevitable, the central committee put itself in correspondence with Count de Stolberg, whom the government had just named commissary general and inspector of the volunteer hospital service of the Prussian army. The nature of the organization of the Prussian Society will be perhaps more clearly indicated by the following extracts from its constitution:

"The central committee has its headquarters at Berlin; provincial and parish societies are considered as subdivisions of the Prussian Society.

"The central committee maintains a constant and regular correspondence with the provincial and parish societies.

"The supreme direction of the corporation is intrusted to a central committee, charged at the same time with representing the Prussian Society abroad.

"This committee is composed of at least 24 members, 15 of whom must reside at Berlin.

"The government appoints three commissioners to the central committee, who have for mission to aid the committee by their counsels, to serve as mediums between the society and the war department, in order that the committee may distribute its succors according to the wants of the army, and connect its hospital and sanitary service with that of the ambulances and hospitals of the army. The commissioners of the government are considered members of the committee and take part therein."

THE PRUSSIAN SANITARY INSTITUTION DURING THE COMBAT OF LANGENSALZA.

Hardly had war been inaugurated before the central committee of the Prussian Society had the opportunity of demonstrating to all how powerful was the organization created by the corporation, and with what favor its appeal to patriotic and humane sentiments had been received by the entire nation.

A detachment of Prussian troops had marched to meet the Hanoverian army which was moving towards the south, in order to effect a junction with the Bavarian troops. The shock between the Prussian corps and the main body of the Hanoverians was very violent; both sides fought with extreme obstinacy, and the contest lasted for five hours. The Prussians, after displaying prodigies of valor, were obliged to fall back, which they did in good order. The Hanoverian army experienced enormous losses; and the day, although glorious for the flag of Hanover, proved dearly the inutility of a prolonged struggle against the Prussian forces. The Hanoverians retired upon the town of Langensalza, and the Prussians camped in the neighborhood. The bloody combat was not yet terminated when the insufficiency of the resources which the Prussian

medical corps could dispose of was felt in a cruel manner; and as to the resources of the Hanoverians, they were nearly nothing.

Such was the situation when the royal commissioner to the central committee of the Prussian Relief Society, Count de Stolberg, received information at about 5 o'clock in the afternoon that there were 1,500 wounded at Langensalza who were absolutely in want of bread. Immediately the central committee, with a most commendable activity, responded to the call; after midnight three special convoys left the Berlin station, bearing the succors of the Sanitary Society to the field of battle. Among the supplies sent forward were 1,072 bandages, 150 plaster preparations, 4 bottles of chloroform, 124 mattresses, 150 compresses, 500 shirts, 102 towels, 100 pairs of socks, lint, slippers, wadding, drawers, surgical instruments, chocolate, and a host of other things destined to relieve or revive the wounded. We see that the committee had shown itself provident, and was ready at the first appeal to fulfil its duty, nobly and worthily.

One of its members accompanied the expedition, as also eight physicians, and several male and female volunteer nurses, among whom were six deaconesses of the Institution of Protestant Sisters. At Magdebourg several other physicians and nurses united themselves with the members of the Relief Society. The central committee had taken care to telegraph to the local committee of Gotha an order to prepare vehicles for receiving the supplies shipped, so that no delay was encountered, and the convoy reached the little town of Langensalza early in the morning.

No one was prepared for so terrible a carnage; the hospital service was wanting not only in nurses, but, strange to say, it did not even possess the necessary material for arranging a single ambulance hospital; so the wounded Hanoverians and Prussians were placed upon such straw as could be hastily procured; some were lying upon the ground, few were they to whom a bed, furnished with a straw matting, had been given. The army surgeons, exhausted by fatigue, were distressed at the sight of so much suffering which they were powerless to alleviate. We may judge then of the satisfaction experienced when they saw the arrival of a long train of wagons which brought them all those different things so much needed: bedding, lint, bandages, compresses and provisions. We may fancy their gratification when they saw coming to their aid the male and female nurses, and the physicians the Relief Society had sent. Every thing was soon transformed, and a better aspect of affairs followed. All the wounded Prussians and Hanoverians were installed in good beds, order was established and anxieties ceased.

THE PRUSSIAN SOCIETY DURING THE BATTLE OF SADOWA.

It has been shown with what intelligence and energy the central committee of the Prussian Society gave aid and assistance to the medical department of the army at the first conflict between the hostile forces. Yet that was, so to speak, only the first trial made by the institution of

its forces. From that moment it became conscious of what it could realize, and when graver and more decisive events occurred to astonish Germany and Europe, almost immediately after the combat of Langensalza, the Prussian Society proved in a splendid manner the great services a work based upon the free co-operation of a united people can render in such solemn moments.

The Prussian troops had penetrated into Bohemia by the narrow defiles of Saxony and Riesengebirge. A series of bloody battles had conducted them to the banks of the Elbe before the fortress of Königgratz. Here upon the hills and in the vast plain which are near that city the grand and memorable battle took place, which will remain in the annals of history as one of the greatest events of the 19th century.

More than 500,000 combatants confronted each other on the morning of the third of July. The shock was terrible; from eight o'clock in the morning until five in the evening the roar of cannon was incessant; and when towards evening the King of Prussia, who had directed the battle, put himself in pursuit of the formidable Austrian army that he had just conquered, more than 40,000 wounded strewed the immense space which stretches from the village of Sadowa to Chlum, and from Nechanitz to the fortress of Königgratz. We may easily fancy the work which the Austrian and Prussian surgeons had to do on this bloody day; the Prussian surgeons particularly, for we must remember that the Austrian army in its retreat left almost all its wounded upon the field of battle, abandoning to the generosity of the enemy the task of picking up and providing for them. The surgeons of the Prussian army did not fail in this duty; they took care of Prussian and Austrian with equal solicitude; in acting thus Prussia was not obeying a natural sentiment of generosity and humanity alone, but was fulfilling the engagements to which she had subscribed in signing the treaty of Geneva. I shall never forget a scene which I witnessed in the little village of Milowitz. In a wooden house, with about 20 other wounded, a young Hungarian soldier was lying, his leg badly swollen. There was evidently a bone fractured near the ankle, and the ball had remained in the wound; still there existed some doubt on this subject. Nothing could be more touching than the solicitude with which the surgeon-in-chief and the other physicians examined the patient. Mr. de Langenbeck, while probing the wound, addressed words full of kindness to the sufferer; he encouraged him to support patiently a pain which he could not spare him. I followed with undisguised admiration the skilful hands of the surgeon, when suddenly turning towards us he said, "the ball is here." Then addressing himself to the patient, he added, "now, be at rest my boy, you shall soon return home to those who love you."

This fact is cited not simply to exhibit a trait of goodness and humanity, but because I believe that in a large number of cases an encouraging word renders less cruel the sufferings of the wounded in foreign countries, far from those who are interested in and attached to them. In hospi-

tals where the sick are nursed by women, they will often find opportunities to speak of their homes and those they have left there; but in the military hospitals that I visited in the villages of Bohemia, there were none of these women by the bedside of the wounded. To see the gentleness and the goodness of the nurses and physicians, one would say that they wished to give their patients the same care and attentions that Sisters of Charity would have shown for them.

At the very moment when the first battles took place in the defiles of Saxony and Bohemia, the committee sent forward to these countries a shipment of medical and sanitary supplies having a total weight of more than 50 tons, together with 440 casks of wine. The convoy arrived at Gitschin the day before the battle of Sadowa, and the King of Prussia, after having personally conferred with the members of the committee that followed it, ordered that the material should be distributed in the field hospitals which had been established in the different places where the Prussians had been victorious, from Nachod to the town of Gitschin. A part of the goods, nevertheless, was reserved for the wounded that were constantly brought back from the different battle fields. The convoys of wounded formed a long line of carriages advancing slowly and with difficulty. When the delegates of the society met these wounded a sad sight was offered them: in heavy wagons men were lying upon straw, who, after having received a first dressing of their wounds, had remained from 30 to 48 hours without food. All the resources of the country had been exhausted, and one cannot think without shuddering of the fate which would have inevitably befallen a portion of these men if the commissioners of the Relief Society had not arrived there at the decisive moment to offer provisions to the sufferers and recall them, as it were, to life.

A few days after, a more considerable train started out from Berlin. The battle of Sadowa had been fought, and the Prussian army was moving rapidly upon Vienna. Another battle not less bloody was anticipated, and it was necessary at the same time to face the double exigencies of the moment. One of the convoys, forwarded by the society on receiving the news of the great battle, had an approximate value of $60,000, and among the things were four tons of ice, destined for the service of the hospitals. The committee sent forward every day, during a fortnight, a train of supplies for Bohemia. To introduce order in an enterprise so great and so difficult, the necessity was felt of establishing grand depots upon the very theatre of operations, from these the field hospitals could be aided according to their wants, and relief carried promptly to the wounded wherever a serious engagement should demand the solicitude of the society's delegates. Such depots were speedily organized at Turnau, Gitschin, and especially at Kœniginhof, Trautenau, Brunn, Pardubitz, Wurzburg, and Wertheim. But in spite of the precautions and wise measures which the central committee had taken, the supplies destined for the army of Bohemia often experienced

unfortunate delays on account of the incumbrances which existed on the railways. I could not resist a feeling of sadness at the sight of the numerous wagons which remained whole days in the railway stations from Dresden to Prague. These delays were the more lamentable from the fact that, while considerable shipments of provisions were spoiling in the stations, pressing wants were felt in the hospitals of Brunn and the vicinity, where the cholera was raging with violence.

The states allied to Prussia also placed at the disposition of the central committee the products of public benevolence. The free city of Bremen, for instance, despatched to Berlin at one time $8,000 in specie, 400 casks and 1,300 bottles of wine, 380 bottles of port, 900 pounds of tobacco, 47,000 cigars, 2,000 pounds of sugar and 1,000 pounds of rice; the days following, shipments as considerable arrived from this same city and the Grand Duchy of Oldenbourg, while the city of Hamburg sent immense quantities of ice.

The central committee distributed with intelligence and without parsimony the resources it possessed. After the battle of Sadowa, and shortly after the treaty of Nickolsbourg, it made a shipment to Prague which, by its proportions, reminded me of those forwarded at times by the United States Sanitary Commission to the federal army. This train or convoy was composed of 22 wagons, and I noticed among the supplies then sent 50,000 pounds of meat, 34,000 bottles of red wine, 1,500 bottles of cognac, 20,000 pairs of slippers, 5,000 flannel belts, 62,000 cigars, and a host of other things as useful as varied.

Independently of the depots where it stored its supplies, the Relief Society had organized at the principal railway stations, particularly at the branch line or junction stations, grand buffets, where its agents were busied in distributing succor to the wounded who were passing, as well as to the field hospitals established in the vicinity of these stations.

Pardubitz, for example, is a railway station on the line leading from Dresden to Vienna, and forms a point of junction for several branch roads. From eight to ten thousand men were in garrison there, and toward the end of July the military hospitals of the place were crowded with cholera patients. At this important point the society had established a principal depot, which was able to supply the hospitals with every thing necessary for their sick and wounded, and with all the food suitable for convalescents. In addition, it had fixed in the railway station one of these buffets of which I speak, in order to be better able to distribute its help to the troops that passed, or were temporarily stationed there. It gave daily to each soldier, convalescent or suffering, beef soup, meat, a large glass of wine, a small glass of cognac with sugar or fresh water, bread, cigars, and in the morning a cup of coffee and sweetened bread. From the month of May to July, the number of soldiers passing through Pardubitz and assisted by the society amounted, on an average, to 300 daily. Another branch of this kind, established at Bodenback, an important station on the railway from Dresden to Vienna, distributed in the

same manner and in the same time, refreshments to 5,500 convalescents and to 5,000 well men, fatigued from long travel. This branch establishment, intrusted to the direction of Mr. Auerback, a distinguished professor of Berlin, who had voluntarily offered his services to the society—this establishment, I say, placed each day 500 rations at the disposal of the troops who passed, and each ration consisted of a half pound of meat, a loaf of white bread, a goblet of wine, a small glass of brandy and a glass of sugared water, for the soldier in health; if the soldier was unwell or convalescent, he was offered another of soup or broth. It is to be regretted that in such cases these branch establishments did not have at their disposition the excellent beef extract of Borden, which makes one of the best broths that can be offered to convalescents.

At the end of the war the Prussian Society of Relief to the wounded had expended in specie a sum of about 2,000,000 of francs for completing its supplies of provisions and in relieving the wounded; on the other hand, it had received in kind and distributed articles of a value estimated at 6,000,000 of francs. Certainly these are considerable sums; but the intelligent manner in which these treasures have been distributed has, so to speak, doubled the value of them. It is proper to add, moreover, that if the society has been able to obtain so great results, it has been specially due to the energy and self-sacrifice of its agents, who have fulfilled everywhere, voluntarily and without remuneration, their noble and difficult mission with a perseverance as admirable as it was unfaltering. In justice we must also observe that the Prussian government seconded powerfully the efforts of the society in authorizing it to use gratuitously the railways, post and telegraph.

KNIGHTS OF THE ORDERS OF SAINT JOHN AND MALTA.

Besides the Prussian Society of Relief, there were other relief societies, such as the Society of Kœnig Wilhelm, and the Society of Relief to the Army, which had likewise for their mission the succoring of the wounded. Endeavors were made, without success, to effect a coalition between these and the Prussian society; the Society Kœnig Wilhelm nevertheless charged the central committee of Berlin with the distribution of relief in kind, which it forwarded to the army.

An institution that rendered great services in the hospitals during the whole war was the Order of the Knights of Saint John. This order, restored in Prussia in 1812, had until latterly been only honorary. It is still necessary to be descended from noble parents in order to become a member of it. Already at the time of the Schleswig-Holstein campaign the members of this order, recollecting the elevated mission of the ancient knights of Saint John, of whom they considered themselves the perpetuators, wished to be useful by consecrating themselves to nursing the sick and wounded. During the campaign against Denmark, the Order of Saint John had organized a sanitary service and had sent several of its members to the hospitals and to the battle-fields.

When the war broke out between Prussia and Austria, the former government conferred on the grand master of the Order of Saint John, Count Stolberg-Wernigerode, the title and powers of commissary general and military inspector of the volunteer hospital service. He was also appointed government commissioner to the central committee of the Society of Relief to the wounded. This society, through the earnest and cordial concurrence of Count Stolberg, contracted an intimate alliance with the Order of Saint John. A member of the order received the special mission of maintaining relations of fraternization between the society and the order of knights. By this union the Relief Society was enabled to extend its operations greatly, for everywhere upon the wide field of events the Knights of the Order of Saint John were present as delegates of their grand master. By a special combination these knights were almost always delegates at the same time of the Relief Society. It was these knights who were most frequently placed at the head of the numerous depots which the society had established in Austria; it was they who, in their quality of hospital volunteers, acquainted the Relief Society with the wants of the different hospitals in which they were serving.

The Order of Saint John is an evangelical Protestant institution. Throughout the whole war it did not cease to render eminent services; it generously accepted for its line of conduct the principles of the international convention of Geneva, and lavished its attentions without distinction upon friends and enemies.

Rivaling in zeal the Knights of the Order of Saint John were the knights of the Catholic Order of Malta. Associating themselves in the arduous efforts of the sanitary companies, the members of these two orders have courageously done their duty upon the battle-fields, and in the field hospitals, as well as in their quality of commissioners intrusted with conducting the trains sent by the Relief Society, and with distributing the supplies forwarded. I have remarked that the Prussian Relief Society had not succeeded in centralizing in its own hands the resources of the other analogous societies which were in operation at Berlin. It is proper to add, however, that there did not exist between these societies any antagonism, and that all carried into the accomplishment of their task the same earnestness and the same ardor.

RELIEF SOCIETIES IN SAXONY AND SOUTHERN GERMANY.

In Saxony, at the first news of the engagements that had taken place in Bohemia, several relief societies were voluntarily organized at Dresden, Leipzig, Chemnitz, and Ziltau. The women especially distinguished themselves by their eagerness in preparing lint, and placing at the disposal of the different committees which they had instituted, linen, refreshments, and provisions.

When the trains of wounded arrived at Dresden, such a number of women presented themselves at the hospitals that the medical officers had to intervene and refuse them access; they brought their offerings

pell-mell, moved by a noble sentiment of compassion, but without order and without discernment. And then they demanded at times that the refreshments which they came in person to offer to the wounded should be given in preference either to the Saxons or the Austrians. Little by little order was established, the service of voluntary relief centralized, and, through the judicious efforts of the president of the Saxon society, the excellent and indefatigable General de Reitzenstein, they were enabled to distribute advantageously to all the wounded the relief in money and in kind which arrived abundantly from all the districts of Saxony. The regular hospital of Dresden having become insufficient, the military school and several other establishments, particularly a large public school, were converted into hospitals. Thus transformed, the latter building seemed to me to satisfy all exigencies as a well-aired and well-ventilated hospital.

The civil physicians of Dresden rivalled in zeal the military physicians of Prussia, and I doubt whether wounded soldiers ever received more intelligent and kinder attentions than those in the hospitals of Dresden. As much could be said of those in the hospital of Zittau, when the ablest physicians of the district came by turn to give their assistance to the military surgeons.

If we now direct our attention to Southern Germany, we there see also energetic endeavors to organize and centralize the sanitary service upon the principles of the Geneva convention, and even a certain tendency to profit from the example given by the United States Sanitary Commission. This tendency was manifested particularly in Wurtemberg, where several local relief societies were organized in the different towns of the kingdom as soon as the conflict appeared inevitable. The service of all these societies was centralized at Stuttgard under the direction of the Sanitaets Verein, an international society that was placed under the direct patronage of the Queen. There was, besides, a great enthusiasm in all classes of the population, on account of the energetic impulse given to the movement by both the King and Queen; indeed it could hardly be otherwise, since Wurtemberg had been one of the first powers to sign the Geneva convention.

The Queen manifested in this undertaking a continued and commendable activity. It was she, so to speak, who initiated the country into this humane work. By her efforts meetings were inaugurated at Stuttgard and in the principal towns of the country, in which all classes of society were made acquainted with the aim and utility of relief societies. And when the conflict had commenced, and hospitals were established to receive the wounded, the Queen did not fail in the duty which she had voluntarily imposed upon herself, but went frequently to stimulate by her presence the courage of the patients as well as the zeal of those who had spontaneously offered themselves to nurse them.

I have seldom heard more elevated and just views as to the part that sanitary institutions were destined to perform in time of peace and war

than those which the Queen was pleased to communicate to me when I had the honor of conversing with her about the results accomplished by the United States Sanitary Commission. Never, she said, had she experienced a sentiment of greater satisfaction than when, having recognized how many services women could render to humanity, by taking part in the sanitary movement, she had consecrated herself to the mission of actively propagating the sanitary reform in her kingdom.

Through the concurrence of all those who, by their position or knowledge, could influence the population, the resources of the sanitary society rapidly augmented, and during the short campaign in which the troops of Wurtemberg were engaged, it was enabled to render important services in sending relief of every kind, as well as male and female nurses, to the field hospitals established at Fauberbischofsheim and the neighboring villages, after the bloody battles which had taken place upon the banks of the Mein. It even sent assistance to the wounded in Bohemia and to the hospitals of Vienna, of Berlin, and of Munich. In the Grand Duchy I noticed an activity not less intelligent, and an excellent organization of the international society of relief for wounded soldiers. But what is truly curious and specially to be observed is, that in the Grand Duchy it was, as in the United States, women who first had the generous thought of founding societies of relief to the wounded.

As early as 1859, the Badischer Frauenverein, an association of ladies of the country of Baden, was organized at Carlsruhe, through the initiative of the Grand Duchess Louise, with the object of succoring the wounded during a war which seemed imminent at that period. Although the threatened scourge was diverted, the association, which had spread throughout the country, continued in activity by adapting itself to the exigencies of peace, without, however, abandoning its primary object. The central committee, sitting at Carlsruhe under the presidency of the grand duchess, and having under its direction seventy-four collateral committees in the country, instituted, in 1861, a work which we cannot sufficiently recommend to the attention of other sanitary societies: it founded schools for nurses, in view of the attentions to be given to sick and wounded soldiers.

These female nurses are instructed in the hospitals of Carlsruhe, Pforzheim, and Mannheim. I see, in an interesting work which her royal highness has forwarded me, that these devoted women, after an apprenticeship of three months under the vigilant eye of physicians who give them daily theoretical and practical teaching, undergo an examination, and the central committee gives them a certificate according to their capacities. When they have terminated their instruction, those who return to their homes in the city or country remain, nevertheless, under the direction of the local sanitary committee. A part of the nurses stay in the hospitals, where they perfect themselves. Lastly, some occupy an establishment at Carlsruhe founded by the society, and nurse the sick at their homes gratuitously, in time of peace.

Such was the situation of this relief society when the internationa' convention of Geneva took place, and to which the Grand Duchy of Baden was one of the first adherents. The end proposed to be accomplished had already been foreseen by the society of the ladies of Baden; it had even already organized one of the branches of service most strongly recommended at the congress of Geneva. So that there was no necessity of creating in the Grand Duchy a new association especially charged to represent the international convention.

But when, in the month of July, 1866, the hope of preserving peace had disappeared, the Grand Duchess Louise proposed to the Minister of War to intrust to the society, over which she presided, the functions of the international society. This demand having been accorded without hesitation by the grand ducal government, the Badischer Frauenverein became from that time a member of the international society of relief to the wounded, and it must be admitted that, during the war, it constantly proved itself equal to its mission, and has worthily fulfilled the noble duties intrusted to it.

From the time when the Baden troops first began to experience the fatigues of forced marches, even before they had engaged in the combats of the Mein and Tauler, the international society, under the presidency of the grand duchess, ably seconded by the Princess Wilhelm, displayed a continued activity.

To stimulate the zeal of all, the grand duchess, accompanied by the princess, was seen to labor with the other ladies of the committee, in overlooking with extreme attention and solicitude the operations of the society. From the commencement of the campaign relief in abundance reached the army—cigars, eatables, and refreshments of all kinds; but after the engagements of the 25th and 28th July, in which the Baden division had taken part, the central committee of Carlsruhe forwarded to Wertheim and Tauberbischofsheim a number of its female nurses, who rendered eminent services in the temporary hospitals, where wounded Prussians, Bavarians, Wurtembergians, and Badners were lying side by side. "They fulfilled," says the work we have cited, "their arduous duties to the full satisfaction of the physicians and the wounded, and succeeded in conquering the distrust which they encountered at their arrival. Some of them belonged to the highest classes of society. Besides the services which they rendered, their excellent influence, full of gentleness, the order which they knew how to organize in the small hospitals committed to their care, and the consolation which they infused into the hearts of the suffering, bear evidence how important it is that women of education and refinement should consecrate themselves to the care of the hospitals. The assistant surgeons, whose work in attending the wounded was too laborious for women, gained much by association with the lady nurses, and fulfilled their difficult duties with more zeal and consideration."

The resources which the association possessed, by reason of the emu-

lation which the central committee had inspired in the country, were so considerable, that at the end of the campaign it had forwarded assistance to Bohemia, to Vienna and Bavaria, to be distributed there in the military hospitals.

In Bavaria, also, the sanitary movement was extensive; and there, too, were associations, of women especially, which organized the service of relief to the wounded; and, by the active intervention of these associations, the surgeons of the Bavarian army, after the affair of Kissingen, had at their disposal a large quantity of lint, linen, bandages, and instruments, at the same time that refreshments and provisions of every kind were sent to the hospitals.

AUSTRIAN RELIEF SOCIETIES.

After the battle of Sadowa, most of the wounded who had not been abandoned to the care of the Prussian army were transported to Prague and Vienna; the former having been left in the hands of Prussian physicians, public solicitude was directed principally to the multitudes of wounded in the capital.

From the beginning of hostilities, an association which had already been in operation during the campaign of Holstein, re-entered upon active service with increased vigor and under a new form. It was called the Patriotischer Damenverein—patriotic society of ladies. As soon as war was determined upon, it placed itself under the presidency of Princess Schwarzenberg, and appealed to all persons in the empire known for interesting themselves especially in works of benevolence, in order to engage their participation in the association, and accord to it their earnest co-operation. The first reunion of the associated ladies took place at the princess's residence, and numbered only twenty-seven persons. A few days later, however, a second meeting assembled forty, who undertook to procure a thousand florins each for the society. They exerted themselves with so much zeal and devotion that, shortly after this second reunion, the society had at its command a sum of 110,000 florins instead of the 48,000 which it had asked for. When the trains of wounded arrived, the Emperor placed at the disposition of the Patriotischer Damenverein two physicians, one of his palaces in Hungary to be used as a hospital, and surgical instruments; while the Sisters of Charity, ever present where there are sick to be cared for, offered their services to the association.

Thus it was that the association of Austrian ladies became one of the principal sanitary societies of Austria, and rendered great services to the country, under the presidency of a distinguished woman, who had given up to the society for hospital purposes her handsome palace, with its riding-house and stables. This lady undertook, besides, the lighting and warming of the establishment, so that the association was charged only with the expense of feeding the sick and wounded; it could consequently dispose of its funds more freely in favor of the sick and con-

valescent. The society gave to each convalescent on leaving the hospital Schwarzenberg—which contained 120 beds—10 florins; and to those who had suffered amputation of limbs, from 150 to 200 florins; to the officers, who left the château before they had entirely recovered, it gave, according to circumstances, 450 and even 650 florins. Notwithstanding these liberalities, it still possessed sufficient capital to assure to soldiers who had undergone grievous operations a life income of 60 florins.

But the solicitude of the ladies of this association was not confined alone to the Schwarzenberg hospital; even before the last sick of the temporary establishment were transferred to the hospital of the order of Saint François, one of the members, the Countess de Lowenthal, whose indefatigable exertion was the admiration of the population, had already called the attention of the society to this institution sustained by the liberality of the imperial family, and which the Emperor Maximilian had endowed with a sum of 21,000 florins. In this hospital of the order of Saint François, Madam de Lowenthal, by the attentions which she lavished upon the wounded, stimulated a laudable emulation among the hospital employés, and is an additional example of the happy influence always exerted in such circumstances by the presence of ladies of refinement and position.

If this society of ladies rendered good services by the devotion of its members, the Patriotic Society, from which women were excluded, was the one, of all the Austrian institutions organized and in operation during the war, which most resembled, in its organization and manner of operating, the American society. It had its central committee at Vienna, and local associations in most of the cities of the empire. It selected its members among men of readiness and willingness in all classes of society; and, like the sanitary associations of Prussia and the United States, it had volunteer hospital corps organized, who were in waiting at the principal railway stations to give the first attentions to the wounded who arrived, and distribute refreshments among them. Under the firm and able direction of its president, Prince Colloredo Mansfield, this association, having its origin in the free concurrence of the people, rendered such important services to the army, that one of the first measures of Archduke Albert, when he took command of the army of the north, was to make sure of its co-operation.

When, some time after the battle of Sadowa, I visited the Austrian sanitary establishments, the hospitals of Vienna were crowded with wounded, and in most of them, in consequence of insufficient light and ventilation, the mortality was very great. One hospital, however, contrasted advantageously with the others, by its cleanliness, the disposition of its halls, and its good ventilation. Yet it was an improvised hospital, called at Vienna the Holzhospital, because it had been established in a wooden edifice destined for an agricultural exhibition which took place at the Prater. This hospital was intrusted to a ladies' society under the

presidency of Madam Ida von Schmerling. Founded the 20th of June, this society, called Damen Comite, had about fifty members. Some of these established themselves in the hospital confided to their care. They had a difficult task to discharge, for there were, in the large hall alone of the building, more than five hundred sick to provide for. This establishment, with a single story well aired and lighted, reminded us forcibly of the wooden hospitals such as were constructed in the United States.

The immense influence exercised by a proper ventilation in hospitals is demonstrated by the fact that in the establishment of the Prater there were but 12 cases of cholera, only two of which proved fatal, while the epidemic raged cruelly in the other hospitals. But a fact still more striking is, that out of 5,000 wounded, treated in that establishment, only 62 died. Besides, only two cases of mortification were observed, and cases of pyæmia were very rare. It is proper here to add that the director of this hospital, Doctor Abl, constantly gave proof of a zeal and intelligence beyond all eulogy.

THE ITALIAN SOCIETY OF RELIEF TO THE WOUNDED.

At the conference of Geneva, the Italian members took an active part in the debates, and the King of Italy was one of the first to adopt the agreement emanating from these deliberations. As soon as the object of the convention had been determined, the medical society of Milan, under the inspiration of its president, Doctor Castiglioni, named a commission charged with preparing the statutes of a relief society. This commission engaged with spirit in the accomplishment of the task committed to it, and on the 15th June, 1864, the Milanese committee of the Italian Association of Relief for sick and wounded soldiers was constituted. This was not only the first Italian committee of the kind, but, in general, one of the first societies organized upon the principles of the Genevese convention. To justify its name of Milanese Committee of the Italian Society, a name which indicated that it was only a member of a society more vast and important, the committee of Milan made a spirited appeal to all the medical societies of Italy, urging them to follow its example and build up relief societies. At the same time that it communicated its statutes to the medical societies, it published them and invited citizens of all classes to give their co-operation in the projected work. This appeal was heard; relief societies were organized at Bergamo, Como, Cremona, Pavia, and Monza; these local associations adopted the statutes of the Milanese committee, and with unanimous consent recognized the Committee of Milan as central committee of the Italian Society of Relief for the wounded, which had the good fortune of inaugurating the international sanitary movement in Italy.

The entire work was placed under the patronage of King Victor Emmanuel, and under the presidency of Doctor Castiglioni, the efficient president of the Milanese committee, of which the prince royal was honorary president. From the outset, the society busied itself actively

in completing its organization, and in obtaining materials and money in order to be ready to fulfil its duties should its services be needed.

The central committee, by reason of its foresight and prudence, found itself ready to accomplish worthily the duties incumbent upon it, when the events of 1866 happened to bring into play all the energies of Italy. At the approach of the danger several other relief associations were founded in localities where their organization had been neglected during peace; and all these societies, those of Ancona, Leghorn, Naples, Ferrara, Turin, and Florence, operated in conjunction with the Milanese committee, which they considered as the central committee of the association. Still, at the very period when the war broke out, an incident occurred which sensibly touched the friends of a work that, before the eyes of the whole nation, was about to test its power and decide a question strongly controverted then in Italy: namely, whether relief organized by the free concurrence of the citizens could really produce the grand results expected of it. The incident to which I make allusion was the proposition to give to the society two centres of operation, one of which would remain at Milan, and the other reside in the committee of Florence. The partisans of this duality supported it by considerations which were not wanting in strength. They alleged that, if the enemy crossed the Po, the communications of the Milanese committee with southern Italy would be destroyed; but that so long as this event was not realized, it was useful to have a centre of action at Milan, situated nearer the theatre of operations.

On the other hand, the opponents of this proposition observed how dangerous it was to introduce a schism in the administration of the society at the very moment when it should exhibit the extent of its power; and to better demonstrate the propriety of having only one central committee, whatever might be the number of local societies and the importance of the work, they referred to the fact that the Sanitary Commission of the United States, which had counted 30,000 committees and had possessed riches to the amount of 125,000,000 of francs, had, notwithstanding, but one central committee, that established at Washington. These considerations they urged should necessarily present themselves forcibly to every mind; but there was still an objection to the measure proposed, not less weighty, and that was, as remarked by Doctor Castiglioni, that the Milanese committee having already been recognized by all the other local societies as the only central committee, it would evidently create confusion in the society at the very moment of action to introduce the element of duality.

After lengthy discussions, and in spite of the opposition of several societies, it was finally arranged in such a manner that the committee of Milan remained the centre and representative of the Italian society in relation with the International Committee of Geneva. But in Italy it operated in reality, during the war, only as central committee of the local societies situated beyond the Po; while, by the very force of circum-

stances, those of central and southern Italy assembled around the Florentine committee. Yet, although forming two centres, the two committees of Milan and Florence remained united in close relations, and their actions were always concerted in such a manner that the relief service did not suffer by their common independence.

During the whole war the Italian Relief Society exhibited a remarkable activity and intelligence. In all the provinces of the kingdom, but particularly in those of the centre and north, there was an enthusiasm and an emulation which did not cease for a single day. The physicians distinguished themselves by their zeal and readiness to enlist under the glorious banner of the society. During the days of Custozza, they were seen upon the field of battle succouring the wounded, and, faithful to the mission of the society, attending Italians and Austrians indiscriminately. The ambulance service of the society also was well organized. The employés of each division of the service consisted of a superior sanitary officer, two assistant sanitary officers, an administrator chosen in preference from the clergy, a chief nurse and eight assistants. The material consisted of the flag of the international society, ambulance satchels, medicine chests, litters so arranged as to be used as tents when required, plain litters, sacks, bottles and goblets in wood to be used by the wounded for drinking, cases of surgical instruments, and several varieties of baskets, for carrying these objects in carriages or on horseback.

The ambulances of the society rendered great services to the regular army and to the volunteer corps; and the assistance in provisions and linen, which the committees of Florence and Milan distributed in the hospitals, prove in a striking manner that all classes of Italian society also understood the grand role reserved for individual initiative, when it became a question of succoring the wounded and cheering the victims of war. And here, as elsewhere, it was the women especially, who, by their courage, their energy and devotion aided the Relief Society to do all that it accomplished. At Milan, Florence, Turin, and Ferrara, they did not confine themselves to delivering lint, bandages, compresses and linen, but they were seen also, especially at Florence and Milan, constantly occupied in aiding the committees in the depots of those cities.

CONCLUSION.

I have explained as minutely as possible at the present time the organization of the international relief societies which were in operation during the recent events in Germany and Italy, mentioning conspicuously the special services they have rendered. I have expressed unhesitatingly on more than one occasion the unfeigned admiration I felt at the sight of the devotion of volunteer physicians and nurses, the good will of sovereigns, and the intelligence and activity of the committees placed at the head of these associations. But if I were now asked what improvements I have been able to observe in Germany and Italy, upon

the work instituted as early as 1861 in America by the United States Sanitary Commission, I am compelled to acknowledge that I have nowhere seen a striking amelioration, or an improvement worthy of being signalized, either in the organization of the material of the ambulances, or in the personal composition of the sanitary societies. I will even say, and I certainly speak without partiality, that it is to be regretted that the experience acquired in the United States during four years of a murderous war was not turned to better profit; it is particularly lamentable that many of the excellent measures employed by the American Sanitary Commission were not adopted by the relief societies in Germany, and lastly that a good number of American inventions appropriate to the service of ambulances were not employed by the different committees.

A long study of the sanitary question, such as it appeared in America, having familiarized me with most of these inventions, I knew what services they had rendered the United States Sanitary Commission, and how much they had aided it to accomplish its glorious but laborious task; so that as soon as the idea of organizing analogous associations in Europe sprung up, and consequently long before the Austro-Prussian war, I had decided to assemble in a collection, as complete as possible, the numerous sanitary apparatus and objects whose utility had been acknowledged during the civil war, by the American commission, in circumstances as serious if not more difficult than those produced by the late European conflict. Having commenced, immediately after the close of the war in the United States, to gather the elements of this sanitary collection, I was already in possession of a large number of useful and interesting appliances when war broke out in Germany; so that when I went to the theatre of action, I made it my duty to call the attention of competent men to such of these inventions as, in my opinion, could be immediately introduced in the sanitary service of the relief societies. These communications, were everywhere favorably received; and I believe that if the war had continued much longer the associations of these belligerent countries would have been necessarily brought to make an application of a large number of these apparatus.

The war being ended, I could not choose a more favorable moment for inaugurating the American sanitary collection, of which I have spoken, than at the opening of the Universal Exhibition. It found there its natural place, in the international exhibition of the societies of relief to the wounded, since the collection was destined to offer to the consideration of the public the numerous and varied means by which the first and most extensive of relief societies had been able to realize the great object it had in view. In conclusion, I will mention that, since the last war which so agitated Europe, earnest and able efforts have been made to popularize in every country the idea of international societies of relief for the wounded. The benefits which these associations have spread broadcast during the war opened the eyes of a great power which up to that time had refused to sign the convention of Geneva: I speak of Austria.

To decide on the question, she had only to compare what had been done in Prussia with what her own sanitary service had realized, notwithstanding the patriotism and good-will of the people.

As to Russia, it could not escape the penetration of the Emperor Alexander that, after a proof so decisive, most of the objections which had been raised against the expediency and efficacy of sanitary societies were dissipated. Russia has therefore officially adhered to the convention of Geneva. It may be said that the international sanitary work becomes now one of the most popular institutions of Europe, and I believe that in order to fortify it, and furnish it with the means of accomplishing in a complete manner its noble mission, no more simple and ingenuous measure could have been taken than to invite to an international exhibition all the societies of relief for the wounded, organized upon the basis of the Genevese Convention.

Thanks to the initiative of the central committee of the French Society of Relief, which made a stirring appeal to the societies of other countries, this order, happy in every point of view, has been realized.

I repeat it, this reunion of all which, in different countries, has been devised for succoring the wounded soldiers, will be the most fruitful among the numerous measures adopted, up to this time, for propagating the international work of relief. Indeed, from the comparative study of the objects, apparatus, and hospitals which have been employed in different countries, the best types may be chosen among the different models presented, and useful inventions for sick or wounded soldiers will thus be adopted in countries where perhaps, without this exposition, they would have long remained unknown.

But this international exhibition will have still a result which, though less immediate, will not be less favorable to the progress of the work, whose success constitutes the object of my most ardent wishes. I allude to the good which must necessarily result for the work from the simultaneous presence at this exhibition of most of the eminent men who take an active part in the labors and operations of relief societies, both in America and in Europe. These men, by exchanging their ideas, hopes, and studies, will mutually enlighten each other upon the objects of their common solicitude, and, no doubt, will carry to their respective societies new and fertile ideas. As additional proof of the reasonableness of this hope, we see that from the intercourse of these men an excellent idea has already been developed, and one to which those who wish sincerely the development of the sanitary work will not refuse their concurrence. We allude to the international conferences of the societies of relief for the wounded, which took place during the Universal Exhibition.

In those international conferences of the relief societies of Europe and of the United States, scientific questions were discussed from a sanitary point of view, and long sittings were devoted to the study of serious improvements relating to the work. About 50 delegates, representing

societies organized in different countries, took part in the interesting deliberations which characterized those international reunions, and obtained the following principal results:

A project for certain modifications in the text of the Geneva treaty of 1864 was unanimously adopted. This project could not fail to be favorably and unanimously accepted, since its principal aim was to make participators in the benefits of neutrality those relief societies which were not in existence when the convention in vigor established the principle of the neutrality of hospitals and their attendants.

Doubtless all the powers signing that treaty will readily and cheerfully give their assent to the modifications proposed by the late international assembly.

In order that the neutrality accorded may be better appreciated, and the result of the conferences fully understood, I give the complete text of the convention agreed upon:

TREATY FOR THE AMELIORATION OF THE CONDITION OF WOUNDED SOLDIERS IN THE ARMIES OF THE LAND AND SEA.

ARTICLE 1. Ambulances, hospitals, and all material destined to aid the sick and wounded, upon land and sea, will be recognized as neutral, and as such protected and respected by belligerents.

ART. 2. The attendants of the hospitals and ambulances of land and sea, including the services of health, of administration and transport, as well as the religious attendance, will participate in the benefit of the neutrality.

ART. 3. The persons designated in the preceding article will be allowed, if they fall into the hands of the enemy, to continue to fulfil their duties in the hospital, ambulance, or vessel where they are placed. Under the enemy's authority they will still preserve their wages, &c.

This sanitary assistance will not be detained beyond the time required for the attention of the wounded, but the commander-in-chief of the victorious army or naval forces will decide when it may withdraw.

The sanitary and administrative service, as well as the wagons, ships, and all material in use of the wounded, will continue to operate upon the field of battle or in the waters where the combat has taken place, even after those places shall have been occupied by the victorious army or the naval forces. However, the wounded removed shall remain in charge of the conqueror. If the sanitary and administrative service should fail in the duties imposed by its neutrality, it shall be submitted to the laws of war.

ART. 4. The members of the societies for the relief of wounded soldiers in the land and naval armies of every country, as also their auxiliary attendants and their material, are declared neutral.

The relief societies will put themselves in direct communication with headquarters of the armies or with the commandants of the naval
of representatives.

The relief societies, in accord with their representatives at the head-quarters of the land or naval forces, may send delegates who shall follow the armies or the fleets upon the theatre of war, and second the sanitary and administrative services in their operations.

ART. 5. The inhabitants of the country, as well as volunteer hospital attendants or nurses, who shall aid the wounded, will be respected and protected.

The commandants in chief of the belligerent powers will invite, by a proclamation, the inhabitants of the country to succor the enemy's wounded, as if they belonged to a friendly army or marine.

Every wounded soldier received and cared for in a habitation will serve as a protection for it.

Every vessel charged with receiving the wounded or shipwrecked will be protected under the colors mentioned in article 7.

ART. 6. The sick or wounded soldiers will be received and nursed, regardless of their nationality. Every wounded person fallen into the hands of the enemy is declared neutral, and must be turned over to the civil or military authorities of his country, to be sent home when circumstances permit and the consent of the two parties is obtained.

The convoys of the health service, with the persons who direct them, will be protected by an absolute neutrality.

ART. 7. A distinct and uniform flag and pavilion are adopted for the hospitals, ambulances, depots of supplies, and the convoys of the health service in the land and marine armies. They must be, in every circumstance, accompanied with the national flag or pavilion.

A badge is likewise admitted for the neutral service.

This badge will be delivered exclusively by the military authorities, who will create for that purpose certain regulations.

Every person illegally carrying the badge will be subjected to the laws of war.

The flag-ship's colors and the badge shall bear a red cross upon a white background.

ART. 8. It is the duty of the victorious army to overlook, as much as circumstances permit, the soldiers fallen upon the field of battle, to protect them from pillage and bad treatment, and to bury the dead in strict conformity with sanitary prescriptions.

The contracting power will take care that in time of war every soldier is provided with a uniform and obligatory sign or mark suitable to establish his identity.

This sign shall indicate his name, place of birth, as well as the army corps, regiment and company to which he belongs. In case of death, this document must be taken off before burial and sent to the civil or military authority of the deceased's place of birth.

The lists of dead, sick, wounded and prisoners, shall be communicated, as complete as possible, immediately after the engagement, to the commander of the enemy's army by a diplomatic medium.

In so far as the contents of this article are applicable to the marine, it will be observed by the victorious naval forces.

ART. 9. The high contracting powers obligate themselves to introduce in their military regulations the modifications become necessary by reason of their adhesion to the convention.

They will order them to be explained to the land and naval troops in time of peace, and will see that they are included in the order of the day in time of war. The commanders-in-chief of the belligerent armies or navies will see to the strict observance of the convention, and will regulate for this purpose the details of its execution. The inviolability of the neutrality set forth in this convention must be guaranteed by uniform declarations, published in the military codes of the different nations.

Another question, equally important, was discussed and resolved by the conference. It became necessary to determine upon what basis should be founded the international centre of relief societies. It was decided, in principle, that a superior international committee, formed of the delegates of different societies, should sit at Geneva, and that a sub-committee, (international,) having its headquarters at Paris, should operate under the authority of the superior committee.

To give to the work at once a progressive and regular movement, a special commission was appointed to examine the propositions of the international committee of Geneva.

The international conference having decided that it would award prizes and medals, these honors were accordingly distributed to the promoters, protectors and co-operators of the international work.

From the preceding pages it will be observed that much has been accomplished. Much, however, still remains to be done through earnest effort and wise counsel, and I most sincerely trust that, as an effective means of realizing our hopes, these international conferences may be continued regularly after the Exhibition, both in France and other countries. May they, multiplying, call to the entire work the sympathy of every nation! Then, and then only, the relief societies will succeed in fulfilling completely their mission: that of mitigating the horrors of war, awaiting the arrival of a more advanced civilization to extirpate the terrible scourge.

THOMAS W. EVANS, M. D. D. S.,

Surgeon to the Emperor, Officer of the Legion of Honor, and Member of the Jury of the Universal Exhibition, (Class 11,) United States Commissioner, &c.

PARIS UNIVERSAL EXPOSITION, 1867.

REPORTS OF THE UNITED STATES COMMISSIONERS.

REPORT

UPON

MUSICAL INSTRUMENTS,

BY

PARAN STEVENS,

UNITED STATES COMMISSIONER.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1869.

REPORT ON MUSICAL INSTRUMENTS.

PIANOS AND OTHER MUSICAL INSTRUMENTS AT THE PARIS EXPOSITION.

THE MANUFACTURE OF MUSICAL INSTRUMENTS IN PARIS—TABULAR STATEMENT OF THE NUMBER OF EXHIBITORS AT THE EXPOSITION AND AT OTHER EXHIBITIONS—HISTORY OF THE INVENTION AND MANUFACTURE OF THE PIANO—THE ERARD PIANO—POWER IN PIANOS—PROGRESS OF MUSICAL EDUCATION IN THE UNITED STATES—MANUFACTURE OF PIANOS IN FRANCE AND IN THE UNITED STATES—NOTICES OF PIANOS AT THE EXPOSITION—ORGANS.

EXTENT OF THE EXHIBITION OF MUSICAL INSTRUMENTS.

The French committee of admission of Group I, Class 10, musical instruments, subdivided and arranged the exhibition of objects in the class as follows: The products exhibited in Class 10 include eight principal series, viz: 1st, church organs; 2d, harmoniums; 3d, pianos; 4th, stringed instruments; 5th, wind instruments; 6th, percussion instruments; 7th, accessories for the manufacture; 8th, editions of musical works.

They observe in regard to the manufacture of musical instruments in France:

"Paris is the only important manufacturing place for organs, pianos, and harmoniums. Then follow, according to importance, Marseilles, Lyons, Nancy, Toulouse, and Bordeaux, where pianos are chiefly manufactured. Stringed instruments are made principally at Mirecourt; wind instruments, in wood, such as flutes, clarionets, hautbois, are more specially manufactured at Lacouture, (Eure.) All kinds of instruments are also made in Paris; Chateau-Thierry has likewise no specialty; nearly all kinds are manufactured there.

"Part of these articles are sold in France, and part to commission merchants, who buy for exportation; a third, perhaps the most considerable, is exported direct, to order, to all parts of the world. The small instruments are worth from 50 to 200 francs; harmoniums from 100 to 1,500 francs; violins and violoncellos from 200 to 500 francs; copper instruments from 80 to 400 francs; wind instruments, in wood, 80 to 300 francs; pianos, 500 to 4,000 francs; church organs from 2,500 to 100,000 francs. The profits of the manufacturers vary from 12 to 18 per cent. The manufacture of musical instruments represents a sum of 20,000,000 or 23,000,000 of francs per year. Raw materials are imported into France

to the value of 5,000,000 or 6,000,000. About half the produce goes to foreign countries, and is exported to all parts of the world, but particularly to America, and chiefly to South America. The importation is inconsiderable."

In the class of musical instruments twenty nations were represented, which rank, with respect to the number of exhibitors, in the following order: First, France, Austria, Italy, England, Turkey, Portugal, Bavaria, and Belgium; second, Spain and Wurtemberg; third, the United States, Switzerland, Sweden, Norway, Russia, and Egypt; fourth, Holland and Denmark; fifth, Baden and Greece; sixth, Hesse; seventh, the Papal States. This order would be greatly different if the contributions were tested by their material value, or by their mechanical and artistic merits. The United States, for example, would take a much higher rank. Turkey would fall below Russia, and hardly take precedence of Egypt.

The annexed comparative table, while of interest as showing the variation in the number of exhibitors at the great Exhibitions of 1851 and 1862 in London, and of 1855 and 1867 in Paris, will also aid us in arriving at an approximate estimate of the relative importance of their contributions. The table is arranged in five sections, each of four columns. Each column answers to one of the four great competitive world's fairs; each section to a kind of instrument. The figures give the number of exhibitors. It is seen that there were in London, in 1851, 180 exhibitors, and in 1862, 335; at Paris, in 1855, 421, and in 1867, 473. If the following average is now made, which for the object in view is sufficiently accurate, viz: to each exhibitor of pianos, 2 instruments; to each exhibitor of organs, 1 instrument; to each exhibitor of stringed instruments, 6; to each exhibitor of wind instruments, 8, the following aggregates are obtained: pianos exhibited, 356; organs, 51; stringed instruments, 420; wind instruments, 656.

Designation for each country of the number of manufacturers in each specialty who were exhibitors.

DESIGNATION OF NATIONS.	PIANOS.				HARMONIUMS, ORGANS, AND ACCORDIONS.				STRINGED INSTRUMENTS.				WIND INSTRUMENTS, WOOD OR METAL.				MECHANICAL INSTRUMENTS AND PARTS, &C.			
	London.		Paris.		London.		Paris.		London.		Paris.		London.		Paris.		London.		Paris.	
	1851.	1862.	1855.	1867.	1851.	1862.	1855.	1867.	1851.	1862.	1855.	1867.	1851.	1862.	1855.	1867.	1851.	1862.	1855.	1867.
England	35	43	16	9	6	10	3	10	12	8	1	1	16	10		1	22	14	14	3
Austria		10	7	26		3	5	3		7	5	9		14	20	15		7	16	4
Baden								1		1	1	1			1				1	2
Bavaria				2					1	1	4	8		3	3	1		4	3	1
Belgium	7	4	8	7			1	1	2	2	1	2	1	2		2			1	
Denmark			4	4							1	1			1				1	
Egypt												3				5				3
Spain	1	1	1	5				1				6				1		1		
Papal States												1							1	
United States	3	4	3	3				2	1	1	4	1				3	1		1	
France	13	17	114	57	1	15	35	25	6	8	22	12	14	17	30	29	2	12	35	45
Greece												4								
Hamburg	3	10	1		1		1			1				1			1	1	1	
Hesse	1	3		2			1					1	3	1						
Holland	1	1	3	1		1	1					1		1		1		1		2
Italy		2		13	1	1		3	1		1	10		3		6		4	3	5
Prussia	1	19	[illegible]	29		2		2		5	3	1		2	1	5	1	2	2	1
Portugal										2	2	2								13
Russia		1		3												2	3	1		3
Saxony		5								3									1	
Sweden and Norway		5	4	6			1			1	1	1				1			3	
Switzerland	4	3	4	3		2		1	1		1		1	1		2	9	3	8	
Turkey												6				7		2		10
Wurtemberg		5	2	8		6	2	2	4		1			1	2	1				
Total	69	132	176	178	9	49	50	51	28	40	48	70	35	62	58	82	39	52	89	92

Of all these instruments the piano merits our chief attention, whether we regard it merely from an artistic point of view, or consider it in its social and even economic relations.

HISTORY OF THE INVENTION OF THE PIANO.

In the monochord, an instrument whose origin is lost in antiquity, is seen the first rude step toward the construction of the piano, the acoustic principle which governs both being the same. As its name imports, it had but one string, which was stretched over two fixed bridges; a third bridge, capable of being placed at different intervals, shortened or lengthened the vibrations, and produced a greater or less acuteness of sound. It served as a diapason, and was used by Ptolemaus (about 140 B. C.) to demonstrate the mathematical relations of sounds. Later benefactors of their kind added other things until they numbered twelve or more, and made changes in framework, mounting, and other appliances; then came the device, the greatest advance as yet in improvement, of setting the chords in vibration by the percussion of two little sticks furnished with cloth balls at their ends.

Thalberg thus speaks of the ancient forms and names of the piano: "More than three centuries ago there were in use two kinds of small instruments with key boards: the *claritherium*, of a square shape, having strings of catgut, which were vibrated by bits of hard leather about a quarter of an inch long, projecting from the side and at the upper end of the jack, which was operated on immediately by the inner end of the key; and the *clavecin*, of nearly the same form as the present grand piano, having strings which were vibrated by plectrums of quill or hard leather. These limited instruments, with others of kindred forms, such as virginals, spinets, and harpsichords, continued in use, with very slight improvements, for two hundred years."

In 1711 Bartolomeo Cristoforo, an Italian, is said to have invented a kind of hammer that struck the strings from below. In 1716 Marius presented to the Royal Academy of Sciences at Paris two horizontal instruments, which he called *clavecins à maillet*, (harpsichords with hammers.) The action of one of them consisted of a hammer suspended on a pin, and pushed upward by an inclined lever, but falling back by its own weight; in the second, the hammers were also moved by levers, but were placed above the strings, and recovered their position by counterweights.

According to some authorities, Cristoforo, adding certain improvements to the work of Marius, produced, two years later, what they style the first piano; the immediate paternity of which others ascribe to Father Wood, an English monk in a Roman convent, and still others to the poet Mason.

What is unquestionable is, that about 1717, some years before Mason was born, Chr. Gottlieb Schröder, of Hohenstein, Saxony, invented, and in 1720 submitted to the Elector, the plan of a piano, in the vain hope

of obtaining patronage. Schröder presented his claims to the invention in a public letter dated 1763.

Godfrey Silberman established the first regular manufactory of piano-fortes, in 1740. The chords of the instruments made by him were arranged in the form of a harp, placed horizontally.

The first square piano is said to have been made by Frederick, an organ-builder in Saxony, and dates from 1758. Another German, Zumpe, introduced the manufacture of square pianos into England about 1760. Streicher in Vienna, at an earlier, and Virbes in France, at a little later date, worked from the models of Schröder.

The harpsichord was now abandoned by artists. Haydn composed sixty sonatas for the new instruments. Gluck composed his Armida and other works on one made for him by Pohlman.

Beethoven used a Streicher to harmonize his famous sonata opera 106.

The invention of the upright piano has generally been accredited to William Southern, a workman in the employ of Broadwood & Sons, of London, in the year 1804. But we find in a letter written by Mr. Jefferson to his daughter Martha, in the year 1800, that he had found, in the city of Philadelphia, "a very ingenious, modest, and poor young man, who has invented one of the prettiest improvements in the piano-forte which I have ever seen. It has tempted me to order one for Monticello." This was an upright piano, and we can find no earlier mention of one. "His strings," the letter continues, "are perpendicular, and he contrives to give them the same length as in the grand piano." In 1809, Wilkinson made the first upright piano with oblique strings.

THE ERARD PIANO.

This brief sketch of the "rise and progress" of the piano, necessarily imperfect if only for its narrow limits, would be inexcusably so were we to omit the name of Erard, one of the most noted in the history of this instrument.

Sebastian Erard was one of three distinguished brothers, children of a Strasbourg cabinet-maker. Antoine, the oldest son, opened a school of design and geometry at Strasbourg. Jean Baptiste went to Germany to perfect himself in the trade of musical instrument maker. Sebastian came to seek his fortune in Paris in 1768, at the age of sixteen, and engaged himself to a clavecin maker. The superior skill of the journeyman soon excited the jealousy of his master, who dismissed him; his next employer was of so much more amiable temper that having received an order, the execution of which required more skill than he possessed, he gave it in charge to Sebastian, but with the condition that the work when completed should bear the master's name. Erard consented; but the secret was not long kept, and his growing reputation was soon after widely spread and confirmed by his "*clavecin mécanique*." He made his first piano for the Duchess of Villeray, who furnished a workshop for him in

her own house. He was now joined by Jean Baptiste, and founded the house that exists to this day.

During the troubles of the revolution, which for a time interrupted his business, he established another house in London. The Strasbourg journeyman cabinet-maker died, full of years and honors, at his own (once royal) Chateau de la Muette, in Passy, in 1831. He left his business and its good traditions to his nephew Pierre.

Of the numerous improvements in the piano which we owe to the Erards two are specially noteworthy: the upward bearing of the strings, patented by Sebastian in 1809, and the repetition action by Pierre, patented in 1821, and again improved in 1827, which combines with a stronger percussion than the old grand action a more delicate effect than the Viennese action.

In the early part of this century the nationality of a piano was distinguishable by its action. If it was English, it had the old English action, the originator of which is unknown; if German, it had the Viennese action, invented by an organ builder of Augsburg; if French, it showed the first system of Erard, or that of Petzhold.

The English action strikes energetically and produces a brilliant tone; the Viennese is more sensitive to the touch, and consequently more favorable to expression; while the Petzhold, or improved English, repeats with more rapidity and precision than either of the former. All of them have been superseded by the double escapement, or new repetition action, of Erard, which unites English force to German delicacy, and either in its original form or with modifications and simplification is now universally adopted.

POWER IN PIANOS.

The next great desideratum with artists and makers was to augment the power of the instrument. The power depends, in the first instance, on the quantity of matter put in vibration; but to increase the quantity of matter, *i.e.*, the size of the chords, was to increase the strain upon the frame.

The amount of tension necessary to bring all the strings of a first class grand piano to the proper pitch is equivalent to a force of more than 240,000 pounds weight.

The mechanical problem that constantly presented itself then was, how to obtain the desired strength of frame without an immoderate increase of bulk. Stodart, Broadwood, Erard, made successive advances towards its solution. In 1824 Erard patented a system of metallic bracing "by bars firmly fixed at both ends to plates and abutments of metal, and employed a number of thicknesses of oak glued together in a mould to form the bent side." The solidity thus acquired permitted the employment of thicker strings and the use of steel wire throughout the scale. Broadwood, in 1827, patented a third system, which combined the metal bars with the metal string plate. These systems mark the main stages

of approach to the desired end, which it was reserved for American ingenuity to attain.

PROGRESS OF MUSICAL EDUCATION IN THE UNITED STATES.

In the first years of this century the taste for music was but slightly developed in the United States. Competent instructors and the material means of culture were hardly to be found outside of the larger towns. Musical education was the luxury of the few, and generally deemed a superfluous accomplishment. Public opinion on this point has been changed as rapidly as wisely, till the children in our common schools are beginning to enjoy the beneficent fruits of this change, and music is properly recognized as a truly useful art—a good and gentle help, meet and comfortable to our everyday life.

With the gradual spread of the love for and desire of culture in the art, there arose a demand for instruments, which domestic manufacture, then in its feeble infancy, was inadequate to meet, and this demand was supplied by importation. Exposed to rough handling in numerous transfers, to the shocks of land travel before the days of railroads, to the hardships of a long sea voyage before the days of steamships, these instruments came into the American warehouse like invalid immigrants to a hospital—bruised, disordered, and suffering. The cost of repairs, always considerable, often nearly doubled the original price of the imported pianos. Being constructed, too, only with a view to the atmospheric conditions of Europe, they were not, even when put in order, sufficiently strong to long endure unimpaired the sudden and trying changes of our variable climate.

Yet let us speak of them with all respect, for they did us good service, encouraging the growth of refinement, which kept pace with our growth in wealth, and softening the asperities that accompany an eager pursuit of material prosperity.

THE MANUFACTURE OF PIANOS IN FRANCE.

The social importance of the piano is beyond all question far greater than that of any other instrument. It is eminently a household instrument, a "friend of the family." At the present day, when it is in some sort taking the place in our homes of the family hearth, and is deemed almost a requisite of housekeeping, the immense demand is met by a domestic manufacture that wields a vast capital, enhances the value of masses of raw material, and gives employment directly and mediately to a multitude of workmen. And in respect to the artisans in this branch of industry it will not be out of place here to mention the fact, often observed in Europe, of their superiority as a class.

In France, out of every 100 piano artizans, 90 read and write and 95 have their own furniture. To any one acquainted with the general conditions of *ouvrier* existence in that country this statement will seem remarkable. Wages are not higher in this trade than in others, varying,

according to the skill exercised, from 3½ francs to 5, and for a comparatively small number of artisans 15 francs per day.

The annual production of the trade is valued at from 20 to 23,000,000 of francs; there is a large exportation to foreign countries, especially to South America.

MANUFACTURE OF PIANOS IN THE UNITED STATES.

The oldest existing American house for the manufacture of pianos is that of Chickering & Sons. It was founded in 1823, by the late Jonas Chickering.

He began by bringing together and under his personal supervision the various processes of fabrication for all parts of the instrument, from keys to case. In 1837 he engaged the services of Alpheus Babcock. Babcock was the inventor of the entire cast iron frame, the fourth and final system of bracing, the greatest improvement recorded in the history of the piano, certainly since 1824, not to assume an earlier date. It was applied with the most satisfactory results to square pianos by Swift & Wilson, of Philadelphia, with whom Babcock was associated; but it was not until he entered the establishment of Chickering that it received its last modifications and was adapted to the grand and upright piano.

Babcock's patent was obtained in December, 1825, for a cast-iron ring or frame to take the strain or pull of the strings, already referred to as so enormous.

In 1833, a square piano, with a full cast-iron frame, was exhibited by Conrad Meyer, at a fair of the Franklin Institute, in Philadelphia.

The piano manufacturers were slow to adopt metallic frames and preferred to rely upon solid and heavy bed-plates of wood; but, as the compass and power of the instrument was increased, and consequently the strain upon the frame, it was found that wood could not give the necessary resistance, and the iron frames were resorted to, and were rapidly improved.

In 1840, Jonas Chickering, of Boston, obtained a patent for an "iron wrest plank bridge," with a projection to hold the wires of the English dampers. In 1855, Messrs. Steinway & Sons, of New York, made a piano with a solid front bar and a full iron frame, and with the wrest-plank bridge made of wood.

The reporter upon musical instruments, Mr. Fétis, member of the international jury, says,[1] that "the secret of the great tone of the American pianos consists in the solidity of the construction, which is found as well in the square piano as in the grand piano.

"The instrument which was and still continues in general use in America is the square piano, which has almost disappeared from European manufacture. The principle of solidity of the American pianos is

[1] Rapports du Jury International, II, 258.

found in the iron frame, cast in one solid piece, which resists the tension of the strings instead of the wooden framework of the European pianos."

After noticing the invention by Babcock, and the exhibition made by Meyer, in 1833, he says: "The first who thought of employing these frames for the solidity of the instruments was a manufacturer of Philadelphia, named Babcock; he finished the first instrument of this kind in 1825. In 1833, Conrad Meyer, another maker, of the same city, exhibited at the Franklin Institute a piano with an entire cast-iron frame. These manufacturers did not understand the advantages of their innovation; these instruments being strung with strings too thin and not in equilibrium with the metallic frame, their tone was thin and had a metallic sound. In 1840, Jonas Chickering, of Boston, founder of the family of piano-makers of that name, took a patent for an iron wrest-plank bridge with a projection (socket-rail,) both being cast with the frame in one solid piece. He commenced to use heavier strings on this apparatus, the sonority of which was found to be better. As is always the case, this invention was improved by degrees. To day the strings of the American pianos are a great deal heavier than those used by the French, German, and English makers. To place them into vibration, the hammers required a more energetic attack than in the English and French actions; hence the considerable increase of the strength of tone. But this advantage is balanced by the hardness of attack which renders the blow of the hammer too perceptible, an objection more offensive in the grand than in the square piano.

"On the 20th of December, 1859, the firm of Steinway took a patent for a system in grand pianos, which in great part does away with the defect just designated. In this system the iron frame received a new disposition for the placing of the strings and the overstrung bass.[1]

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[1] This improvement is described by the Messrs. Steinway (cited in the report of Mr. Frederic Clay upon musical instruments, British Reports, vol. II, class 10, p. 203) as follows:

"This improvement consisted of the introduction of a complete cast-iron frame, the projection for the agraffes *lapping over* and *abutting against* the wrest-plank, together with an entirely new arrangement of the strings and braces of this iron frame, by which the most important and advantageous results were achieved. The strings were arranged in such a position, that in the treble register their direction remained parallel with the blow of the hammers, whilst from the centre of the scale the unisons of the strings were gradually spread from *right* to *left* in the form of a fan, along the bridge of the sound-board—the covered strings of the lower octaves being laid a little higher and crossing the other ones (in the same manner as the other strings,) and spread from *left* to *right* on a lengthened sound-board bass bridge which ran in a parallel direction to the first bridge. By this arrangement several important advantages were obtained; by the longer bridges of the sounding-board a greater portion of its surface was covered; the space between the unisons of the strings was increased, by which means the sound was more powerfully developed from the sounding-board—the bridges, being moved from the iron-covered edges, nearer to the middle of the sounding-board, producing a larger volume of tone, whilst the oblique position of these strings to the blow of the hammers resulted in obtaining those rotating vibrations, which gave to the thicker strings a softness and pliability never previously known. The new system of bracing was also far more effective, and the power of standing in tune greatly increased."

"The disposal of these strings inthe shape of a fan was adopted, distributing their whole number on different bridges over the sounding-board. In the treble of the piano, these strings continued to be placed parallel with the direction of the hammers, it being known that in the square piano this position of strings produced tones more intense in this part of the instrument. In the middle the strings were placed in the shape of a fan, from right to left, as far as the space permitted. The bass strings, spun upon steel wires, were placed from left to right above the others, upon a higher bridge placed behind the first. The advantages of this system are as follows:

"1. The length of the bridges on the sounding-board is increased, and the large spaces, which previously had not been utilized, are effectively employed.

"2. The space from one string to the other is enlarged, from which follows that their vibration develops itself more powerfully and freely.

"3. The bridges placed more in the centre of the sounding board, and consequently further removed from the iron covered edges, can act with more energy on the elasticity of this board and favor the power of tone; moreover, in keeping the same dimensions of the instrument, the length of the strings is increased.

"4. The position of the strings, in the middle and the bass, obliquely to the blow of the hammer, produces circular vibrations from which result soft and pure tones.

"The system of overstringing is not new; it has been tried several times without success, having been employed without intelligence; for, instead of favoring the vibration of the strings in spreading them, the vibration was damaged by laying them too near each other. It will be seen hereafter that the European manufacturers of pianos have exhibited very good instruments constructed after this system.

"The upright piano has only come into use in the United States within a few years. Messrs. Steinway have introduced, in the construction of this kind of instruments, new improvements, which insure the solidity so necessary in the variable temperature of the climate of the United States.

"These improvements consist in a double iron frame and cross bars being cast in one piece. The left side remains open, and through this opening the sounding board is inserted; a special apparatus is adapted to this board, which consists of a certain number of screws, serving to compress the sides of the board at will.

"The success of this combination for beauty of tone, solidity, and standing in tune, determined Messrs. Steinway to apply the same system to the construction of grand pianos, the powerful tone of which has become more singing and more sympathetic, by these means of compressing the sounding board. Messrs. Steinway received patents for this important improvement on the 5th of June, 1866.

"From what has been said, it may be inferred that the large tone of

pianos is a true acquisition to art; an acquisition the results of which may be increased by future improvements, and the great merit of which cannot be doubted except by settled prejudice."

NOTICE OF PIANOS AT THE EXPOSITION.

UNITED STATES.

In no branch of industry did the United States win more distinction at the Universal Exposition of 1867 than in the manufacture of piano-fortes. The splendid specimens exhibited by the two firms that have been mentioned, Messrs. Steinway & Sons, of New York, and Messrs. Chickering, of Boston, created a profound sensation not only with artists and professional musicians, but also with the musical public at large. Both firms exhibited grand, square, and upright pianos, and each received a gold medal upon the award of the international jury. The award of two gold medals to piano manufacturers in the United States is the more significant and gratifying, when it is considered that the jury on musical instruments awarded but four gold medals, and that no member of this jury was from the United States.

The American mode of bracing, as exhibited at the Champ de Mars, excited the profoundest interest among European artists and makers.

Another feature of the American instruments that also attracted great attention was the fact that their scales, being much larger than those of European make, produced a peculiar freedom and clearness in the vibrations of the strings, and as a second consequence a firmness and roundness of tone not observable in any other piano-fortes at the Exposition.

How to augment the sonority and how prolong the sound *ad libitum*, were the problems that European manufacturers had been studying for years. They recognize a satisfactory solution of the first in the instruments of Steinway and of Chickering.

The following is the expression of the opinion of Mr. Fétis, of the jury, translated from his report already cited:

"The pianos of Messrs. Chickering & Sons are powerful and magnificent instruments, which, under the hands of a virtuoso, produce great effects and strike with astonishment. Their vigorous sonority is carried far, free, and clear. In a large hall, and at a certain distance, the listener is struck with the fulness of tone of these instruments. Nearer by, it must be added, there is combined with this powerful tone the impression of the blow of the hammer, which produces a nervous sensation by its frequent repetition. These orchestral pianos are adapted to concerts; but in the parlor, and principally in applying them to the music of the great masters, there is wanting, by the same effect of the too perceptible blow of the hammer, the charm that this kind of music requires. There is something to be done here, to which the reporter must call the attention of the intelligent manufacturer of these grand instruments, without in other respects wishing to diminish their merits.

"The pianos of Messrs. Steinway & Sons are equally endowed with the splendid sonority of the instruments of their competitor; they also possess that seizing largeness and volume of tone, hitherto unknown, which fills the greatest space. Brilliant in the treble, singing in the middle, and formidable in the bass, this sonority acts with irresistible power on the organs of hearing. In regard to expression, delicate shading, and variety of accentuation, the instruments of Messrs. Steinway have over those of Messrs. Chickering an advantage which cannot be contested. The blow of the hammer is heard much less, and the pianist feels under his hands a pliant and easy action which permits him at will to be powerful or light, vehement or graceful. These pianos are at the same time the instrument of the virtuoso who wishes to astonish by the *éclat* of his execution, and of the artist, who applies his talent to the music of thought and sentiment bequeathed to us by the illustrious masters; in a word, they are at the same time the pianos for the concert-room, and the parlor, possessing an unexceptional sonority."

The cycloid piano, exposed by Messrs. Linderman & Sons, of New York, attracted some attention by its peculiarity of form, but received no recompense from the jury.

Two systems of construction for grand pianos are now generally adopted in the United States. In one all the strings are parallel; in the other the bass or covered strings are crossed as in the square piano. The second arrangement is practiced with advantage in the latter instrument, because the limits of the case, and especially of the width of the sounding board, do not admit a long and broadly expanded scale; but no corresponding advantage is derivable from its application to the grand piano, where there is ample space in length and breadth.

It was practiced many years since in France by both Erard and Pape, but was afterwards relinquished on account of the imperfect and confused vibrations caused by the two bridges being placed on nearly the same part of the sounding board. It seems to us—and the opinion of celebrated experts coincides with ours on this point—that it is useless to have recourse to the contrivance of overstringing where there is sufficient space for a parallel distribution of the strings. The reasons for preferring the parallel system are based on the laws of acoustics, and confirmed by the direct testimony of scientific experience.

An attentive comparative study of the American and German instruments, and of the specimens of overstrung and parallel strung grand pianos in the Exhibition, has practically proved the superiority of the parallel in arrangement. In all that were cross strung or over strung one peculiarity was remarked which cannot but be deemed a defect; for the crossing of the bass strings on a sensitive part of the sounding board that is graduated for plain steel strings makes the bass too powerful and preponderant.

Something has been said of late of an independent sounding board attached to the pianos by screws and metallic bands. This is not a new

nor an original American contrivance. It was invented and patented in France by Pape, in 1828; and its practical application to an upright and to a grand piano by Cadby was exhibited at London in 1851. It has long since been renounced both by Pape and Cadby. They found that this plan of attaching more or less firmly to the instrument its most vital part, the sounding board, could not be made to co-exist with the requisite solidity of construction.

Before closing the observations upon pianos from the United States we may be permitted an expression of regret that more of our manufacturers, such as Bradbury, of New York, Knabe, of Baltimore, Hallet and Davis, of Boston, and many others, were not represented at the Paris Exposition, where, we have no doubt, they would have also borne honorable part in the peaceful contest in which Chickering and Steinway have won so brilliant a triumph.

The masterpieces of ingenuity, mechanical skill, and artistic excellence presented by these gentlemen are so highly appreciated that many European makers have already begun to build from their models, and there is but little doubt that within a few years the old methods of construction will be as thoroughly abandoned in Europe as they are in America.

In addition to the honorable award of the jurors, the American manufacturers have received from eminent artists certificates and other testimonials of their approval, and many distinguished amateurs have ordered for their own use a "Steinway" or a "Chickering."

GERMAN, ENGLISH, AND FRENCH PIANOS.

In the German, as in the French and English sections, we have been struck with the number of specimens, and with the comparative inferiority of the majority of them. Generally speaking, the German pianos have a peculiarly dull and muffled sound. The gold medal was awarded to Streicher, of Vienna.

The English pianos possess a certain brilliancy in their sonority, which, however, lacks something in clearness and freeness. The defect is probably occasioned in part by the thickness of the strings and the garniture of the hammers.

The French pianos are distinguished above others by their refined purity and delicacy of tone, but become harsh and wiry when forced in the forte. When we speak of French pianos we naturally mean those of the principal houses—Erard, Pleyel, Wolff & Co., and Henri Herz. Of these the first preserves its early supremacy.

Most of the other firms deal only in upright pianos, which all bear a striking common likeness in scale, disposition of the strings, and every other respect, except the name of the so-called maker.

The constituent parts of the instruments, such as keys, action, scales, &c., are made separately and in quantity by as many different makers. The work of the self-styled piano manufacturer consists simply in putting together and adjusting these parts and adding his name to the composition. They are quite moderate in price and very moderate in quality.

ORGANS.

The most important instrument on exhibition was the great cathedral organ constructed by Merklin, Schutze & Co., of Paris for the new church at Nancy. It was so large that it could not be shown in the gallery among other musical instruments, and was placed in the outer circle with the machinery. It was remarkable not only for its size, power, and tone, but was in every respect a beautiful specimen of workmanship, and it contained all the latest improvements and important additions that have been made in instruments of this class. Some of the principal of these improvements may be noted as follows:

1. Method of supplying air whereby the organ is more equally filled and with less labor than is generally required in an instrument of its great power.
2. A system of pneumatic leverage, and a special arrangement by which each row of keys is influenced.
3. The arrangement of the coupler pedals and combination pedals in groups and series.
4. The combination of a variety of stops.

Of stops there were forty-four, besides fifteen pedals for coupling and combination. The stops were distributed as follows:

	Notes.	Stops.
1. Swell organ	56	10
2. Great organ	56	15
3. "Recit Expressif"	56	10
4. Pedal organ	27	9
Total		44

In regard to the external appearance of this instrument the jury for Group II, Class 10, report as follows:

[1]"The jury have noticed with satisfaction that the manufacturers of this grand instrument have preserved in it the character of a church organ, in accordance with its ultimate destination, instead of overloading it with fanciful designs, which, although they may display the genius of the mechanician, do not ever enter into serious art; moreover, the various means which are resorted to to produce these effects have the serious inconvenience of occupying exclusively the attention of the organist, of injuring the free flight of his musical thought, and of diminishing the merit of his performance.

"After hearing an excellent artist perform some of the grand compositions of Bach upon this instrument, the jury are convinced that this organ has all the qualities desirable for power, majesty, and variety. The examination to which it has been subjected in its details has shown that in the finish of the work there is nothing more to be desired, as well as

[1] Rapports du Jury International, Vol. II, page 242.

in the interior arrangements, which give easy access to all parts of the instrument."

Merklin and Schutze exhibited also two other organs from the great establishment at Brussels; and their display, taken as a whole, was remarkably good, and was recognized by the award of a gold medal.

A moderate-sized, but very beautiful organ, made by Cavaillé-Coll, of Paris, was exhibited in the chapel in the park. Some of the stops, such as the "vox human," and "vox cœlestia," were remarkably fine; and in all respects this was a very rich-toned and well-voiced instrument. The price of this organ was $3,000.

From England there were two organs, one exhibited by Messrs. Bryceson Brothers, the other by Messrs. Bevington and Sons. That manufactured by the first-named firm was styled a "mediæval Gothic organ." The wood work of the case was richly ornamented and painted; and the pipes were illuminated in colors and gold. It was composed of twenty-two stops and 832 pipes, and had five composition pedals. The "chancel organ" of Messrs. Bevington was a fine instrument, with twelve pedals, C to G, of good tone and remarkably cheap, its price being only £80, ($400.)

Under the name of "cabinet organs," Messrs. Mason and Hamlin, of New York and Boston, exhibited instruments which attracted considerable attention, and were awarded a silver medal. The improvements which these exhibitors claim to have made are: 1, an automatic bellows swell; 2, self-adjusting reed valves; 3, noiseless safety valves for the prevention of the hissing sound so frequently heard; and, finally, a combination register.

LIST OF AWARDS.

In the official catalogue of awards by the international jury, (*Catalogue Officiel des Exposants Récompensés par le Jury International*,) a list is given of exhibitors who, by their connection with the jury, were placed *hors concours*. They were as follows:

SCHIEDMAYER, J. AND P., Stuttgart, (J. Schiedmayer, member of the jury,) pianos and harmonium, Wurtemberg.

CAVAILLÉ-COLL, A., Paris, (associate member of the jury,) organs.

DEBAIN, A. F., Paris, (associate member of the jury,) harmoniums.

ERARD, MME., Paris, (Schaeffer, associate member of the jury,) pianos.

HERZ, HENRY, Paris, (associate member of the jury,) pianos.

PLEYEL, WOLFF & COMPANY, Paris, (Wolff, associate member of the jury,) pianos.

VUILLAUME, J. B., Paris, (associate member of the jury,) instruments played with a bow.

GRAND PRIZE.

SAX, A. J., Paris.—Wind instruments, (copper.)

GOLD MEDALS.

BROADWOOD AND SONS, London.—Pianos.

STEINWAY AND SONS, New York city.—Pianos.

CHICKERING AND SONS, Boston and New York.—Pianos.

SOCIÉTÉ ANONYME POUR LA FABRICATION DES GRANDES ORGUES, Paris, (establishment of Merklin-Schutze,) Paris and Brussels.—Organs.

ALEXANDRE, FATHER AND SON, (Société des Magasins-Réunis,) Paris. Organs.

FRIEBERT, F., Paris.—Wind instruments, (wood.)

STREICHER, J. B., AND SONS, Vienna.—Pianos.

SILVER MEDALS.

Sixty-four silver medals were distributed, chiefly for pianos and wind instruments. Messrs. Mason and Hamlin, of Boston and New York, received one of these medals for their cabinet organs, and this firm was the only exhibitor from the United States that received a silver medal in this class.

BRONZE MEDALS.

Seventy-six bronze medals were awarded. Of this number, exhibitors from the United States received two:

GERMÜNDER, G., New York city.—Instruments played with the bow.

SCHREIBER, L., New York city.—Wind instruments, (copper.)